# RECREATION RESOURCE IMPACTS IN THE BEAR LAKE ROAD CORRIDOR OF ROCKY MOUNTAIN NATIONAL PARK, COLORADO, USA: AN ASSESSMENT OF RESOURCE CONDITIONS AND VISITOR PERCEPTIONS

by

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A thesis submitted in partial fulfillment

of the requirements for the degree

of

MASTER OF SCIENCE

in

Human Dimensions of Ecosystem Science and Management

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2010

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# ABSTRACT

Recreation Resource Impacts In the Bear Lake Road Corridor of Rocky Mountain National Park, Colorado, USA: An Assessment of Resource Conditions and Visitor Perceptions

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Visitor use in parks and protected areas inevitably leads to resource impacts. In order to effectively manage for resource impacts, it is important for managers to not only understand ecological aspects of their system but sociological aspects as well. The two papers presented in this thesis used integrated approaches to better understand the current level of resource impacts within the Bear Lake Road Corridor of Rocky Mountain National Park and to explore visitor perceptions of these impacts. The first paper used traditional monitoring and assessment techniques, as well as recently developed methodologies, to determine the current level of resource impacts and examine areas for potential future resource change. Findings showed that there is significant impact in the trail system, particularly at popular hiking destinations. At two of these popular hiking destinations, with current use levels, there is potential for future resource change. Integration with measures of social norms showed that visitors are frequently experiencing resource conditions within the Bear Lake Road Corridor that are considered unacceptable.

The second paper presented in this thesis explored visitor perceptions of resource impacts in the Bear Lake Road Corridor trail system. Specifically, the goals of the paper were to better understand the specific types of resource impacts that visitors perceive, identify visitor characteristics that influence visitor perceptions, and determine visitor standards for specific types of resource impacts. A self-administered survey and visual survey methods were used to accomplish these goals. Structural equation modeling was used to evaluate the relationship between visitor perceptions and visitor characteristics. Results showed that visitors are most perceptive of resource impacts which are the result of inappropriate behavior, such as visitor-created trails and tree damage, and their experience is most impacted by crowding. Overall, visitors did not perceive ecological resource impacts as affecting their experience or as being a problem within the Bear Lake Road Corridor. Visitors' local ecological knowledge and knowledge of low impact practices were most influential in determining whether visitors perceived certain resource impacts. Finally, visitors were shown to have standards for both visitor-created trails and vegetation loss on visitor-created sites.

(97 pages)

# ACKNOWLEDGMENTS

This work is not the result of a single individual's efforts but was made possible by the input and support of numerous individuals. First and foremost, I would like to thank my advisor, Dr. Christopher Monz, for his unwavering guidance and support. Thank you for believing in my skills and providing me with challenging and exciting projects. Additionally, I would like to thank my committee members, Dr. E. Helen Berry, Dr. Mark Brunson, and Dr. Steve Burr, for their input and guidance. I am also grateful to the S.J. and Jessie E. Quinney Foundation for the funding provided for my graduate studies.

I would like to acknowledge individuals from the National Park Service at Rocky Mountain National Park for their assistance and interest in my research. Specifically, I would like to thank Larry Gamble and Judy Visty for their support throughout my project. Additionally, the field work would not have been possible without the assistance of my uncomplaining, hardworking, field tech, Annie Weiler. A special thank you to Derrick Taff for tackling Photoshop to create the resource impact photos used in my survey. Thank you to Aaron Chadwick for the many careful hours he spent on data entry.

I am especially thankful for the support and encouragement of my labmates and friends. Countless thanks to Kelly Goonan and Dusty Vaughn for reviewing my survey instruments and helping me resolve GIS issues. Also, many thanks to Lisa Vaughn, Meg Thorley, and Dave Iles for their friendship and advice over the past year. Finally, I would like to thank my family for their loving support and patience and for always emphasizing the importance of education.

Ashley L. D'Antonio

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# CHAPTER 1

# INTRODUCTION

In 2007, 217 million people in the United States participated in some form of outdoor activity (Cordell, 2008). As participation in outdoor recreation activities increases, it becomes increasingly important for managers of parks and protected areas to understand the resource impacts associated with visitor use. All recreational activities inevitably cause resource impacts in parks and protected areas. The examination, assessment, and monitoring of these resource impacts are an important part of the field of recreation ecology. The information derived from the study of recreation ecology provides an understanding of the causes and effects of visitor use (Leung and Marion, 2000). Findings from recreation ecology studies can also be used to guide management decisions.

## 1. Understanding Resource Impacts

Resource impacts are of particular interest to both researchers and managers because they affect ecosystem components (vegetation, soil, wildlife, and water) and have the potential to affect the functional ability or the structure of ecosystems (Hammitt and Cole, 1998). The relationship between use and impact is not linear and depends on a multitude of factors. The intensity of impacts is dependent upon the frequency of use, intensity of use, type of use, user behavior, temporality of use, environmental conditions, and the spatial extent of use (Cole, 1981; Monz et al., 2010). For many resource impacts, the relationship between amount of use and amount of impact is a curvilinear relationship (Cole, 1995a, 1995b).

Resource impacts can be examined at various scales within a single park or protected area. The scale and extent at which resource impacts are examined is important for understanding the relationship between visitor use and impacts. Hiking impacts on soil and vegetation may seem

intense and severe at a small scale; however, when examined at the scale of a whole protected area, the impacts may appear minimal (Cole, 1981). The extent of resource impacts is largely depended on patterns of visitor use. Visitor use is generally distributed unevenly throughout a park or protected area; intense disturbance is found in certain, popular places and intensity diminishes in surrounding areas (Leung and Marion, 2000). Manning (1979 in Hammitt and Cole, 1998) described recreation impacts as being organized in a series of nodes, such as campsites and viewpoints, and linkages, linear travel routes such as trails. However, there is potential for resource impacts to become pronounced and dispersed when visitors leave designated trails. The proliferation of visitor-created trails and the formation of visitor sites may be one of the most significant impacts of hiking on vegetation and soils (Cole, 2004).

**2. Resource Impacts at the Human Scale**

Managers of parks and protected areas are charged with the dual task of both protecting natural resources and providing for quality visitor experiences. An understanding of both the biophysical aspects of recreation impacts and social aspects of recreation impacts can help facilitate management decisions that accomplish both tasks. The field of recreation ecology has been mostly divided from social science studies of recreation. There has been an emerging trend in recreation planning to combine research approaches in a more comprehensive manner (Klinsky, 2000; Hillery et al. 2001; Reed and Brown, 2003; Brown et al., 2004; Alessa et al., 2008; Goonan, 2009).

Resource impacts may be of particular concern at the scale of human perceptions. At the human scale, certain impacts may be viewed as beneficial for specific recreational activities (Farrell et al., 2001). For example, bare ground may be viewed positively in a campsite setting. Generally, impacts may be least problematic from a human perspectives scale when they are minimized in aggregate, dispersed at intermediate scales, and concentrated or clustered at large scales (Hammitt and Cole, 1998).

When examined at the human scale, resource impacts have the potential to not only influence ecological conditions but influence social conditions in parks and protected areas as well. Of particular concern to researchers are visitor perceptions of recreation impacts and the factors that may influence these perceptions (White et al., 2008). Managers of parks and protected areas are concerned about recreation impacts that reduce visitor enjoyment and impair the functionality or desirability of resources used by visitors (Hammitt and Cole, 1998). However, managers should not assume that their perception of recreation impacts are the same as those held by visitors (Farrell et al., 2001). Many recreationists do not recognize recreation impacts or may view impacts as beneficial or as having an amenity value (Martin et al., 1989). In general, visitors appear to be more sensitive to inappropriate, avoidable behavioral impacts such as litter or tree damage (Leung and Marion, 2000). Recreationists also appear to be concerned with impacts that decrease the functionality or quality of their experience or with unnatural objects left by previous visitors (Roggenbuck et al., 1993).

An understanding of how visitors perceive environmental conditions can provide guidance for management decisions. However, in order to effectively manage for quality recreation experiences it is important for managers to understand their visitors. Therefore, managers should not only understand the types of resource impacts which visitors are perceiving but also the subjective factors which influence visitor perceptions (White et al., 2008). Identifying the factors which drive visitor perceptions of resource impacts has implications for interpretation and site management.

**3. Integration and Visitor Standards for Resource Impacts**

In addition to understanding the resource impacts which visitors are perceiving and the factors influencing perceptions, measuring the level of impact which visitors find acceptable can be useful for various management frameworks (Manning et al., 2004). Understanding visitor standards for different types of resource impacts can provide specifics about the level of impacts

which visitors find desirable in a particular setting (Manning et al., 2004). The flexibility afforded through visual survey methods used to measure normative standards of resource conditions, allows researchers to examine specific levels of impacts which can be reflective of conditions on the ground.

The procedures utilized in monitoring and assessment studies and recent methodological advancements in Global Positioning System (GPS) tracking of visitors in parks and protected areas allows for novel integration between ecological studies and visitor perceptions and standards studies. Using Global Information Systems (GIS), it is possible to highlight areas within a particular park or protected area where conditions are undesirable to visitors, as well as model visitor interactions with impacts. Such mapping techniques can inform managers of areas within their park or protected area where visitors may be coming in contact with resource conditions which are unacceptable.

**4. Thesis Outline**

This thesis contains two chapters prepared for publication. The two chapters describe an integrated study to examine the resource conditions in the Bear Lake Road Corridor of Rocky Mountain National Park in Colorado. The research was conducted during the summers of 2008 and 2009. The primary focus of the work was to assess the resource conditions of the Bear Lake Road Corridor trail system and understand how visitors perceive current resource conditions. Additionally, the work focused on integrating the ecological aspects of the study with the social science study results to produce meaningful findings which can better inform management decisions.

Chapter 2 describes the methodology used for the monitoring and assessment piece of the study. Traditional recreation ecology measures were used to gather baseline data on the current level of resource impacts in the Bear Lake Road Corridor. In addition, new methodologies were developed to intensively measure ground cover at two key hiking destinations where visitors are

dispersing off of the designated trail. These two areas were mapped according to the susceptibility of the ground cover to trampling impacts. Susceptibility measures were integrated with visitor tracking data to produce a map of areas of potential resource change due to the interaction of vegetation susceptibility and visitor use densities. Finally, visitor standards for specific types of resource impacts were measured in Chapter 3 and integrated with ecological measures in Chapter 2. The visitor standards results were used to map areas within the Bear Lake Road Corridor according to their perceived acceptability by visitors. Further integration was accomplished using visitor tracking data and the extent to which visitors are interacting with undesirable resource conditions was measured.

Chapter 3 describes the methodology used to measure visitor perceptions of specific types of resource impacts, characteristics which influence visitor perceptions, and visitor standards for specific types of resource impacts. A self-administered questionnaire with newly developed scales was used to measure visitor characteristics including experience use history, local ecological knowledge, knowledge of low impact practices, and national park affinity. Additionally, various components of visitor perceptions of resource impacts and the influence of those impacts on the visitor experience were also measured. Results were used in a structural equation model (SEM) to better understand the influence of specific, subjective characteristics on visitor perceptions of resource impacts. Finally, visual survey methods were used to measure visitor standards for specific types of resource impacts. The photographs used were purposefully designed to be reflective of on the ground conditions in the Bear Lake Road Corridor. The results of the visual survey methods were then incorporated into Chapter 2 to map areas of unacceptable resource conditions.

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# CHAPTER 2

# AN ASSESSEMENT OF RESOURCE CONDITIONS IN THE BEAR LAKE ROAD CORRIDOR OF ROCKY MOUNTAION NATIONAL PARK, COLORADO, USA[1]


## Abstract

Understanding the recreation impacts of visitor use in parks is essential for avoiding the impairment of park resources and visitor experiences. In particular, visitor use in areas off hardened surfaces, such as designated trails and sites, can result in rapid and significant changes in resource conditions. This study reports on a monitoring and assessment study in the Bear Lake Road Corridor of Rocky Mountain National Park in which resource change as a result of visitor use off of designated trails and sites was assessed. Standard GPS mapping and assessment procedures were used to create a baseline of recreation use sites, both discreet and dispersed, and visitor-created trails. Additionally, this research integrates traditional recreation ecology measures with social science techniques to understand how visitors are interacting with resource conditions and highlight areas of potential resource change due to visitor use behavior. Results suggest that resource impacts are prevalent and intense throughout the trail system, but were somewhat spatially limited to areas around destination sites (lakes, view sites, etc.) and established trail corridors. Visitors are interacting with resource conditions which are found to be unacceptable for significant portions of their hikes and are using off-trail areas at densities likely to result in additional resource change.


## 1. Introduction

The demand for wildland recreation and nature-based tourism opportunities continues to increase in many protected areas in North America (Cordell, 2008) and worldwide (De Lacy and

[1]Co-authored by Ashley L. D'Antonio and Christopher A. Monz

Whitmore, 2006). With this increased use has come human disturbance and change to the environmental conditions of protected areas, and an associated management effort directed at minimizing undesirable resource impact. Visitor activities in wildland areas inevitably have some consequences to environmental conditions. Fundamental management decisions as to the level of acceptable and appropriate disturbance to natural systems can be difficult and challenging and must be well informed.

Considerable research conducted over the last 40 years has demonstrated the relationships between visitor use and resource change. Recently, this information has been reviewed and summarized (Monz et al., 2010) and the new discipline of *Recreation Ecology* has evolved. Several fundamental principles can be generalized from this body of literature. Recreation activities can directly affect the soil, vegetation, wildlife, water, and air components of ecosystems. Other ecosystem attributes (i.e., structure, function, etc.) can be affected given the interrelationships between ecosystem components. For a given finite space, the relationship between change and use is generally curvilinear, with the majority of change occurring with initial use. Although some generalizations apply, resistance and resilience to visitor use disturbance is ecosystem specific (Cole and Bayfield, 1993). The amount and distribution of use and visitor behavior are primary driving variables in determining the amount of resource change.

Given these principles, recreation ecology studies of two types are generally performed in wildland areas in an effort to assist managers in the avoidance and mitigation of visitor impacts. *Experimental studies* (e.g., Cole and Monz, 2002; Monz, 2002) examine causal relationships between use type and intensity and ecosystem-specific components. These studies employ carefully controlled experimental designs and can determine the levels of visitor use at which a given ecosystem (or ecosystem component) can tolerate. *Monitoring and assessment* studies (e.g., Marion and Leung, 1997) are perhaps more common as managers often find them to be of considerable utility. These studies assess and monitor the location and extent of visitor use and

resource impacts. Conducted over the long term, these studies provide an initial assessment of the current resource conditions, the trends of how impacts are changing over time, and an evaluation of the effectiveness of management actions. Understanding resource condition trends through assessment and monitoring is essential for many aspects of sound adaptive management, particularly in determining the effectiveness of management actions in achieving resource protection goals.

Considerable literature also exists on the management of visitor resource impacts (e.g., Hammitt and Cole, 1998; Manning, 1999). The development of specific, accurate monitoring indicators is considered fundamental to the management process and moreover is an essential process in various management frameworks (Manning, 1999). As such, recreation ecology studies are an integral component of framework approaches adopted by most land management agencies (e.g., Limits of Acceptable Change Planning Framework).

Within recreation ecology, impacts to soil and vegetation are two of the most frequently measured impacts. Various parameters of vegetation and soil impacts can be evaluated to assess current conditions and provide foundational information for management decisions (Cole, 2004). Collected parameters can then be compared to undisturbed control sites to provide an estimate of the resource change resulting from recreation use. Descriptive data about recreation impacts can provide information about the types of impacts, magnitude of impacts, spatial characteristics of impacts, and temporal patterns of impact (Cole, 2004). The most often used parameter of vegetation impact is vegetation cover; the percentage of ground area covered by aboveground plant parts. An easily measured parameter of soil impacts is soil compaction, which can be quickly and simplistically measured using a soil penetrometer (Hammitt and Cole, 1998).

Spatial qualities of impacts to soil and vegetation include such measures as the extent and distribution of recreation impacts (Leung and Marion, 2000). Since recreation impacts, such as hiking and camping impacts, are generally localized little research has been conducted into the

spatial aspects of impacts (Pettebone et al., 2006). Few studies have examined the ecosystem or landscape level effects of recreation impacts. Even fewer studies have thoroughly documented the impacts from off trail hiking or dispersed visitor use (Leung and Marion, 2000). Off trail hiking and dispersed use often lead to the formation of two easily observed and measured indicators of resource impacts; the formation of visitor sites and the formation and proliferation of visitor-created trails.

For resource impacts such as visitor sites and visitor-created trails, which are often dispersed across the landscape, the size of impacts and the pattern of impacts are of particular interest. The advent of geographic information system (GIS) and global positioning system (GPS) technology allows for greater accuracy in the mapping of resource impacts across the landscape. Thus far, there has been limited application of these technologies in the field of recreation ecology (Liddle, 1997). GPS and GIS technology has been used frequently in landscape ecology and conservation biology, but only recently has it been used for monitoring visitor impacts (Pettebone et al., 2006). GPS technology has been used for mapping the location of trails and campsites (Leung and Marion, 1995; Monz, 1998). However, there is potential for greater utilization of GIS and GPS technologies in the field of recreation ecology particularly through integration techniques with social science data. GPS technology is also being used to track visitor use through systems (Hallo et al., 2005; Lai et al., 2007; O'Connor et al., 2005). The resulting GPS tracking data can be integrated with recreation ecology data to better understand how visitors are using resources and interacting with current resource conditions.

The objective of the study was to apply a practical and efficient *monitoring and assessment* approach to study areas in Rocky Mountain (RMNP). Specifically the study had several goals. First was to establish a baseline of resource conditions in visitor use areas off of designated, hardened trails and sites. This information would allow future assessments to determine the trajectory of resource change. To accomplish this goal, all locations within the

study area where assessed for recreation disturbances to areas off of hardened, designated surfaces was present and mapped these locations using GPS technology.

A second goal was to determine areas where resource change is undesirable based on an assessment of visitor standards of resource condition. This goal was accomplished by determining visitor standards of vegetation cover loss and the proliferation of visitor-created trails via visual research methods and determining locations where standards are being approached or exceeded via GIS mapping. GPS tracking data was also used to model the percentage of time that visitors were experiencing various standards of resource conditions. A final goal was to integrate visitor use determinations and modeling with recreation ecology assessments to the greatest degree possible. To accomplish this goal, outputs from visitor use estimates and ecologic conditions were examined such that areas of likely future change could be determined.

## 2. Materials and Methods

### *2.1 Study Site*

RMNP is located in north central Colorado, approximately 160 km from the Denver metropolitan area. RMNP receives over 3 million visitors per year (National Park Service, 2009). One of the most popular destinations within RMNP is the Bear Lake Road Corridor which provides access to many alpine and subalpine lakes and is a popular destination for both day and overnight visitors. In 1998, due to the high level of use in the Bear Lake Road Corridor, RMNP created a shuttle bus system to service the area (Gamble et al., 2007). Ridership on the shuttle bus to the Bear Lake Road Corridor has increased substantially since its installment resulting in apparent increased visitation to hiking destinations in this corridor.

For the recreation ecology assessment and analysis we focused on four primary study sites within the Bear Lake Road Corridor (Fig. 2-1). The first study area was the Glacier Gorge trail beyond Alberta Falls to the trail junction to Mills Lake. The second study area was Emerald

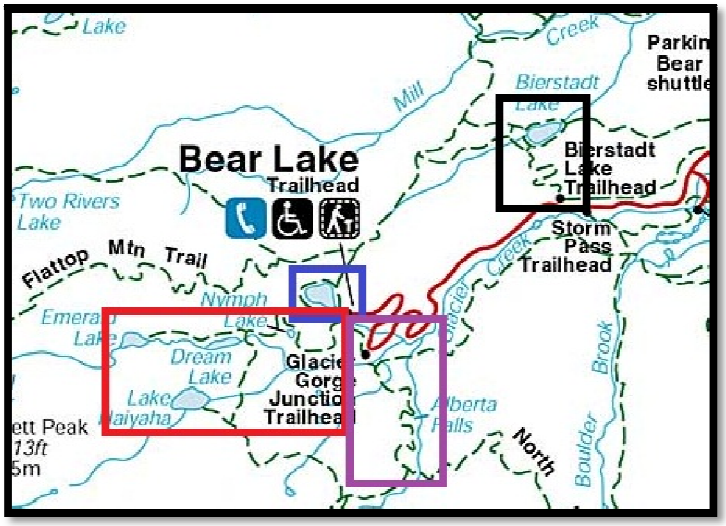


**Fig. 2-1.** Recreation ecology study areas within the Bear Lake Road Corridor.

Lake trail to the terminus at Emerald Lake. The Emerald Lake trail provides access to other popular alpine and subalpine lakes; Nymph Lake, Dream Lake, and Lake Hiayaha. The final two study sites were the trails which circle around Bear Lake and Bierstadt Lake.

*2.2 Resource Condition Assessment*

Preliminary site visits revealed that selected areas exhibited typical disturbances found in park settings: linear and nodal areas of intensive trampling disturbance resulting from visitors hiking off of park designated trails and sites to access water bodies, climbing routes, vistas, or for exploration and other reasons. Managers reported that the proliferation of informal (visitor-created) trails is a common problem that contributes substantial trampling impact to fragile vegetation and substrates. Observations also revealed that visitation frequently resulted in the trampling of substrates and vegetation in many gathering areas and vista sites. Assessing the conditions of these visitor-created trails and sites is particularly important in alpine and subalpine ecosystems because of their limited spatial extent, fragility, and potential for permanent and irreversible vegetation and substrate loss.

To assess conditions of informal, visitor-created recreation sites recreation ecology assessment techniques developed for formal campsites were adapted (e.g., Marion, 1995). For each location, an assessment area was mapped and foot searches identified all recreation sites, defined as nodal areas of visually obvious substrate disturbance created by visitor use. The size of each site was assessed using the radial transect method (Marion, 1995); a permanent reference point was recorded with a Trimble® GeoXT GPS device and Hurricane antenna, and area calculations were conducted in a custom Excel worksheet (Dr. J. Marion, Virginia, USA). Recreation sites which were too small for analysis using radial transect were measured geometrically in the field. Recreation sites which were too large for radial transect methods or showed dispersed use were measured in the field as polygons with the GPS and areas calculated in a GIS environment. All GPS data were post-processed using Trimble's Pathfinder Office to obtain the highest accuracy possible. Vegetation cover and soil exposure were evaluated onsite and in adjacent undisturbed controls as the mid-point value of six cover classes (Marion, 1995). Assessments of the number of trees and shrubs with damage, root exposure, cover on nearby control sites, and assessments of litter/trash also followed Marion (1995). Digital photos were taken to document impacts and aid in site relocation.

Assessing visitor-created trails was more challenging in some areas because the terrain is often dominated by barren rock and visitor-created trails are readily apparent only on soil substrates. Thus, visitor-created trails in these environments are frequently discontinuous and short, increasing the difficulty of locating and documenting the trail fragments and evaluating their condition. While remote sensing techniques are possible, they require expensive high-resolution imagery and complex analytical processing that place this option beyond the means of most land managers. Remote sensing of groundcover disturbance is also challenging in subalpine areas due to the prevalence of well-developed tree canopies.

For this study, a GPS based mapping and assessment procedure was followed, as used in similar surveys such as Leung and Marion (1999) and Marion et al. (2009). The GeoXT GPS and careful foot-based searching were used within each study area to map the locations of all visitor-created trail segments. Two visitor-created trail condition attributes were assessed during field collection as described in Marion et al. (2009): condition class (CC) ratings on a 1-5 scale and an assessment of average tread width (TW). A new informal trail segment was designated and assessed when a consistent change in condition class or width was noted in the field. The intersection of the designated trail with spur segments, sections of visitor-created trails less than 5m in length, were mapped as point features.

### *2.3 Intensive Groundcover Assessment - Alberta Falls and Emerald Lake*

Intensive measurements were conducted at Alberta Falls and Emerald Lake due the importance of these areas from a visitor use perspective and since these areas exhibited diffuse disturbances across large areas. In these areas, a quadrat-based, image analysis sampling technique (Booth et al., 2005) was utilized to measure vegetation and ground cover. This procedure involved three field components: 1) identification and mapping of an area of probable recreation use; 2) creation of a stratified random-grid of sampling locations using ArcGIS 9.3 software; and 3) navigation to sample locations with the GPS and obtaining digital images of $1m^2$ quadrats for subsequent image analysis of ground cover classes.

First the area of possible recreation use was mapped using the GPS, and a polygon was uploaded to ArcGIS (ESRI, Inc., Redlands, CA USA). The extent of this polygon was determined by observable areas of visitor disturbance and by trail and geographic boundaries. Hawth's Analysis Tools extension for ArcGIS was used to create a regular grid overlay on the polygon and random points were generated within each grid square. Quadrat photos were taken at each point on the grid with a Nikon D60 10.2-megapixel digital camera mounted on a frame with a $1m^2$ base

that positioned the camera for nadir (overhead perspective) images 1.4m above ground level. Measurements from digital images were used to quantify the relative cover of ground cover types using SamplePoint software (Booth et al., 2006). Eight groundcover classes were included in the classification of these areas including graminoids, shrubs, forbs, lichens, mosses, organic soil, mineral soil, and exposed rock.

### *2.4 Susceptibility Modeling*

For each quadrat a susceptibility to resource damage score was calculated based on the type and proportion of groundcover present. The score is a weighted index based on the relative tolerance of each groundcover type to trampling disturbance (rated 0 through 5 based on the available literature, especially Cole, 1995) multiplied by the percent cover of each groundcover class. Scores for each quadrat were then used as input for a kriging procedure in ArcGIS that yielded a continuous surface for each polygon based on these ratings. Scores were ranked low to high and susceptibility maps were produced. Low scores included mostly rock, soil, and lichen, medium scores were mostly soil, grasses, and forbs, and high scores were mostly composed of forbs, mosses, and shrubs.

### *2.5 Integration with Social Science and Visitor Use Dimensions of This Study*

Integration with other elements of this study was accomplished in three areas; mapping visitor standards for both vegetation cover loss on sites and the proliferation of visitor-created trails, the determination of visitor exposure to resource conditions, and analyzing areas for future potential change due to visitor use. Visual survey methods were used to determine the visitor standards for vegetation cover loss and the proliferation of visitor-created trails (in Chapter 3 this thesis) used in these analyses. Visitors were shown photographs of increasing levels of resource impacts and rated the photos on a 9-point Likert scale from highly unacceptable (-4) to highly

acceptable (4). Results were graphed as a norm curve and conditions above the neutral line were considered in standard and conditions below the neutral line were considered exceeding standards (see Chapter 3 this thesis). Visitor judgments as to acceptable levels of vegetation cover loss due to recreation use were used to classify all sites assessed in the study. Sites were either within standard, approaching standard, or exceeding standard. Visitor sites were assessed based on the vegetation cover loss calculated from field measures. Additionally, visitor-created trails were assessed in accord with the above classification (i.e., in, approaching or exceeding standards) in accord with the density present at the study site and visual research estimates of acceptable densities.

As part of the overall, larger project in RMNP, a GPS-based tracking study was completed to gather information on visitor use levels and patterns (D'Antonio et al., 2010). Visitors were randomly intercepted and carried hand-held GPS units during the duration of their hike in the Bear Lake Road Corridor. Results from the GPS based visitor use estimation were used to determine visitor's exposure to resources in, approaching, and exceeding standards as a metric of the effect of resource degradation on visitor experience. A buffer of 10 meters, to account for visitor viewscapes, was generated around each visitor tracking point in the trail system. A histogram analysis in GIS was used to determine the number of visitor points within each zone of visitor standards. GPS-based tracking results were overlaid in a GIS environment with susceptibility mapping to highlight areas of potential, future change to ground cover vegetation due to visitor use levels.

## 3. Results

### *3.1 Characterization of Current Resource Conditions*

Assessment of current resource conditions show substantive changes in resource conditions throughout the study area (Tables 2-1 to 2-3) Resource changes are summarized in

**Table 2-1**
Summary of small and medium sized visitor sites.

| Analysis Area | Number of Sites | Total Area ($m^2$) | Mean CC[1] | Mean Area ($m^2$) | Mean Veg Loss (%) |
|---|---|---|---|---|---|
| Bear Lake | 4 | 13.2 | 3.5 | 3.3 | 88 |
| Glacier Gorge | 31 | 368.2 | 3.7 | 11.9 | 88 |
| Emerald Lake | 45 | 478.0 | 3.8 | 10.6 | 82 |
| Bierstadt | 3 | 6.0 | 4.0 | 2.0 | 94 |

[1]CC= Condition class ratings on a 0-5 point scale.

**Table 2-2**
Summary of all polygons; areas of dispersed visitor use.

| Analysis Area | Number of Sites | Total Area ($m^2$) | Mean CC | Mean Area ($m^2$) | Mean Veg Loss (%) |
|---|---|---|---|---|---|
| Bear Lake | 18 | 8064 | 3.4 | 448.0 | 78 |
| Glacier Gorge | 10 | 9548 | 3.8 | 954.8 | 71 |
| Emerald Lake | 21 | 17273 | 3.8 | 822.5 | 74 |
| Bierstadt | 3 | 1532 | 3.7 | 510.8 | 92 |

three overall categories: nodes (sites) of limited spatial extent but exhibiting intense disturbance (Table 2-1); larger areas (polygons) of more diffuse disturbance (Table 2-2) and visitor-created, informal trails (Table 2-3). Nodes of intense visitor disturbance (Table 2-1) occur frequently in the study area and are generally located where visitors congregate—at vistas, along lakeshores, and at other attraction sites. While these areas are limited spatially, they exhibit high levels of vegetation loss (82%-92%; Table 2-1), range from 3.5 to 5 on the condition class scale and occur frequently. For example, along the Emerald Lake Trail (Fig. 2-2), 45 such locations were found, at a rate of one per every 66 meters of designated trail, on average.

**Table 2-3**
Summary of informal trails and spurs.

| Analysis Area | Number of Segments | Total Length (km) | Mean CC | Mean Length (m) | Number of Spur Segments* | Length of Designated Trail (km) |
|---|---|---|---|---|---|---|
| Bear Lake | 47 | 1.1 | 3.3 | 23.2 | 50 | 1.0 |
| Glacier Gorge | 316 | 8.5 | 3.0 | 26.8 | 85 | 3.0 |
| Emerald Lake | 282 | 8.2 | 3.6 | 28.9 | 50 | 3.0 |
| Bierstadt | 15 | 0.8 | 3.2 | 55.9 | 11 | 1.0 |

*Spur is any visitor-created trail <5m in length

Larger areas of more diffuse impacts (polygons) are somewhat less frequent throughout the study area, but occupy considerably more overall area. These areas are particularly prevalent along popular lakeshores such as Bear Lake (see Fig. 2-3) and Dream Lake and at specific attraction sites and destination points (e.g., terminus of the Emerald Lake Trail and Alberta Falls). In general these areas represent locations where visitor disturbances are too randomly located to be classified as a node or linear feature and therefore, cannot be monitored and assessed with standard site and trail metrics. While occupying a fairly extensive area in some cases, overall vegetation loss and condition class of these areas tends to be somewhat less (Table 2-2) than that of visitor sites (Table 2-1), but nonetheless these impacts remain substantial.

Informal trails and spur segments are extensive and frequent in the study area, occurring in all locations (Table 2-3 and Fig. 2-2 to 2-4). In all study areas, the extent of informal trails equals or exceeds that of the system (designated) trails in that area (Table 2-3).

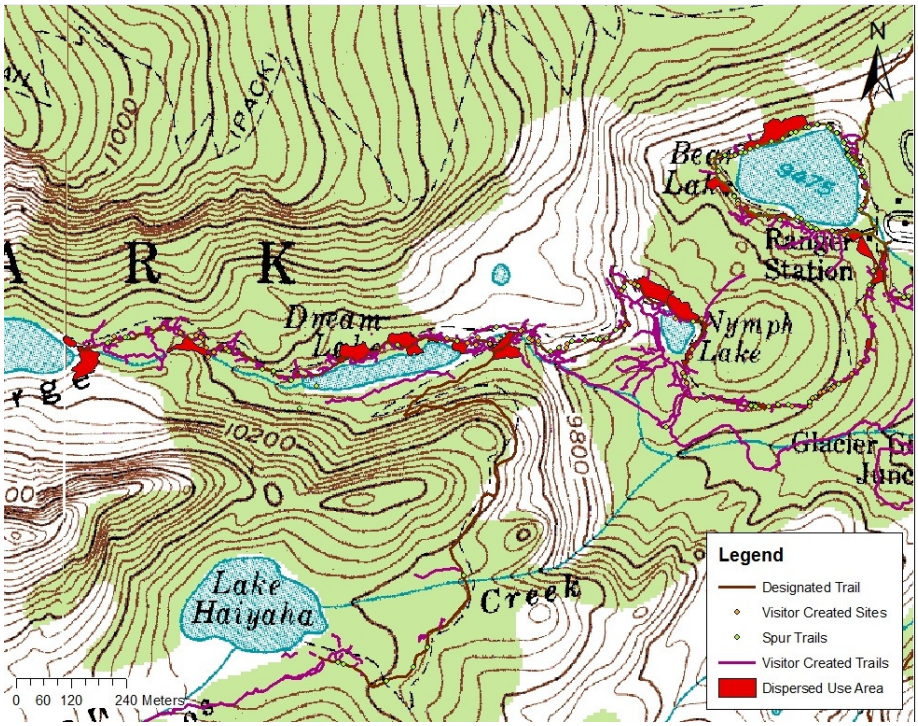


**Fig. 2-2.** Current extent of visitor-created disturbance along the Emerald Lake Trail.

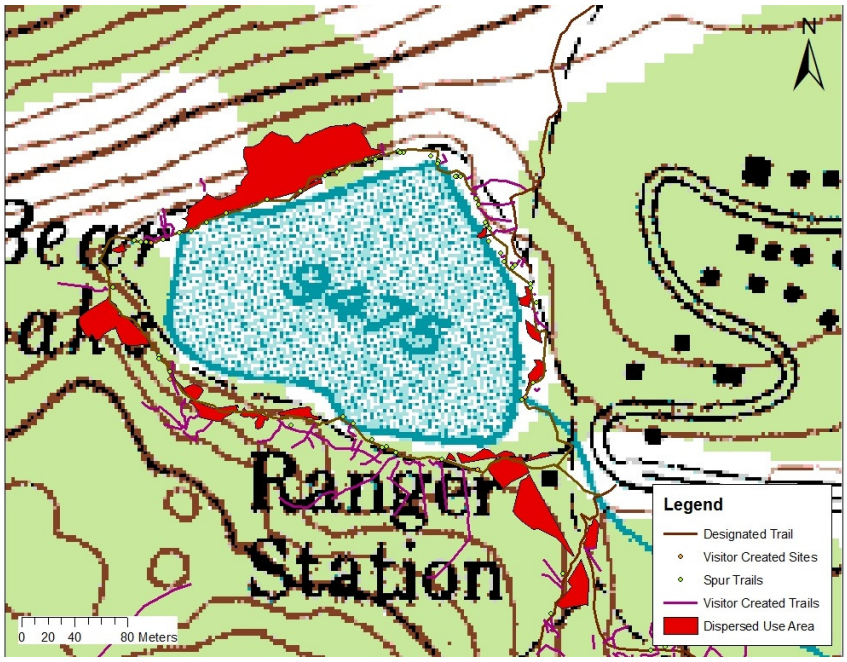


**Fig. 2-3.** Current extent of visitor-created disturbance near Bear Lake.

Although mean segment length for these trails ranges only from 23.2m to 55.9m, trail formation is extensive, particularly in the Glacier Gorge (Fig. 2-4) and Emerald Lake areas where the number of segments found was 316 and 282, respectively. Spur segments (sections of informal trails < 5m) are also common and widespread.

*3.2 Intensive Measurements at Alberta Falls and Emerald Lake: Susceptibility Modeling*

Results of the susceptibility modeling procedures indicate that substantial areas of groundcover near Alberta Falls are sensitive to potential change from current condition, i.e., these

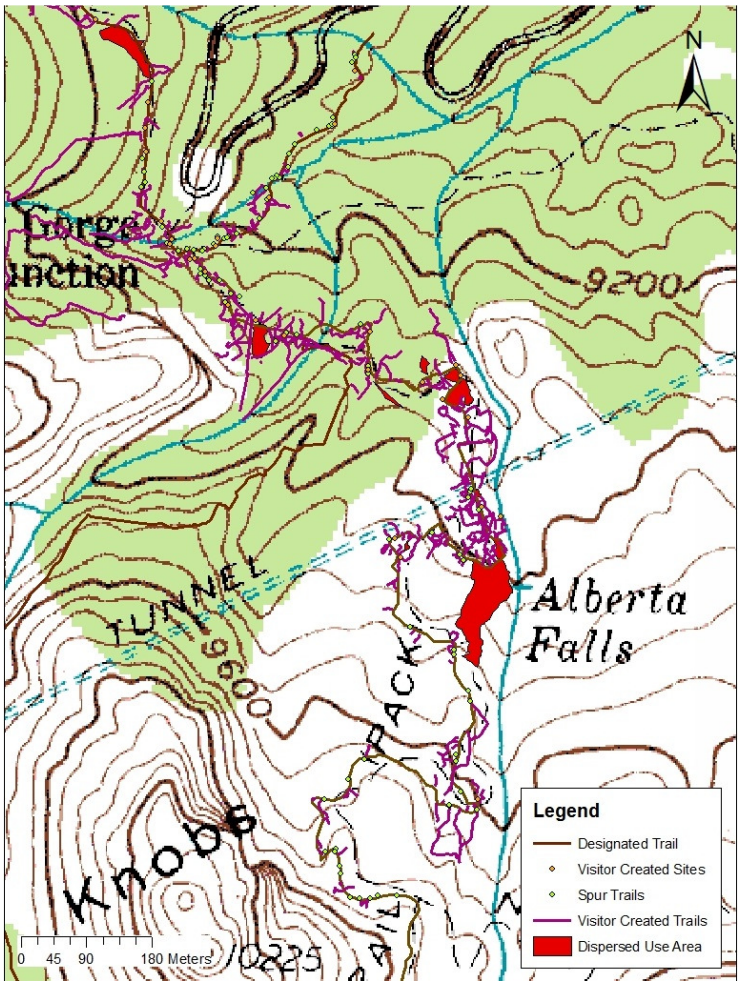


**Fig. 2-4.** Current extent of visitor-created disturbance along the Glacier Gorge trail including Alberta Falls.

resources are located within the use polygon and are relatively intolerant to trampling (Fig. 2-5). At Emerald Lake, more areas of bare rock and exposed soil currently exist, resulting in less vegetated areas of high susceptibility (Fig. 2-6). The areas of high susceptibility at Emerald Lake are those found within the few stands of trees and areas of often woody ground cover. Bare rock is only found directly adjacent to Alberta Falls (Fig. 2-5) and therefore the polygon of dispersed use near Alberta Falls has more areas of high susceptibility. The vegetation adjacent to Alberta Falls is primarily composed of forbs and woody species.

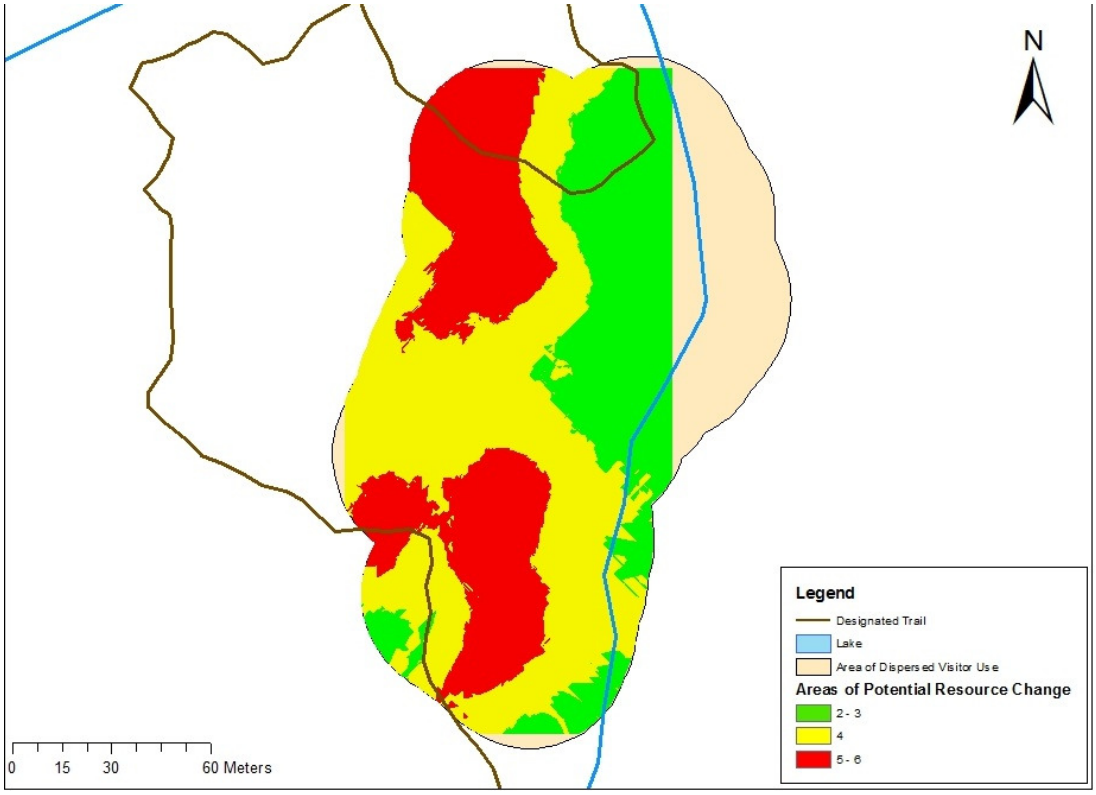


**Fig 2-5.** Areas susceptible to additional groundcover change near Alberta Falls.

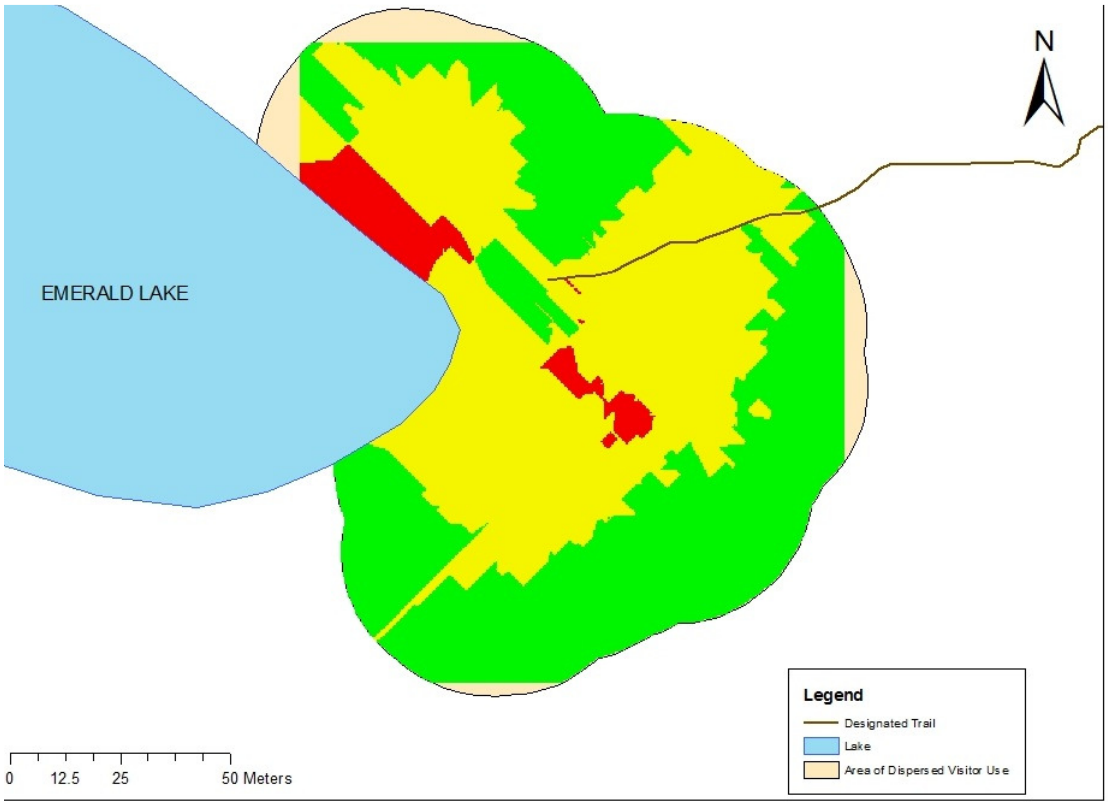


**Fig. 2-6.** Areas susceptible to additional groundcover change near Emerald Lake.

*3.3 Integration with Social Science and Visitor Use Dimensions of this Study*

*3.3.1 Areas Exceeding Standards for Vegetation Loss*

Results from the normative visual research conducted in this study (see Chapter 3) were integrated with the assessments of current conditions to determine which areas of resource change approach or exceed visitor thresholds of acceptability. In the visual research, thresholds of tolerance (norm curves) for vegetation loss and visitor-created trail formation were determined. In this analysis, findings show that a 53% percent cover loss on sites was the minimally acceptable condition and an overall visitor-created trail density of 115 km/km$^2$ was the minimally acceptable condition for visitor-created trails. GIS analysis reveals the location and extent of these conditions for the study area (Fig. 2-7).

Overall, visitor-created trails are more prevalent throughout the trail system than visitor sites. However, due to the dispersed nature of the visitor-created trails (Fig. 2-7), 8% of the total area analyzed is out of standard for density of visitor-created trails. Although recreation sites are fewer in number (Fig. 2-8 to 2-9), the impacts are more intense, resulting in 42 polygons out of 52 total polygons (81%) exhibiting vegetation cover loss that is out of standard. Smaller sites also exhibit intense levels of impact with 81 out of 84 sites (96%) being out of standard.

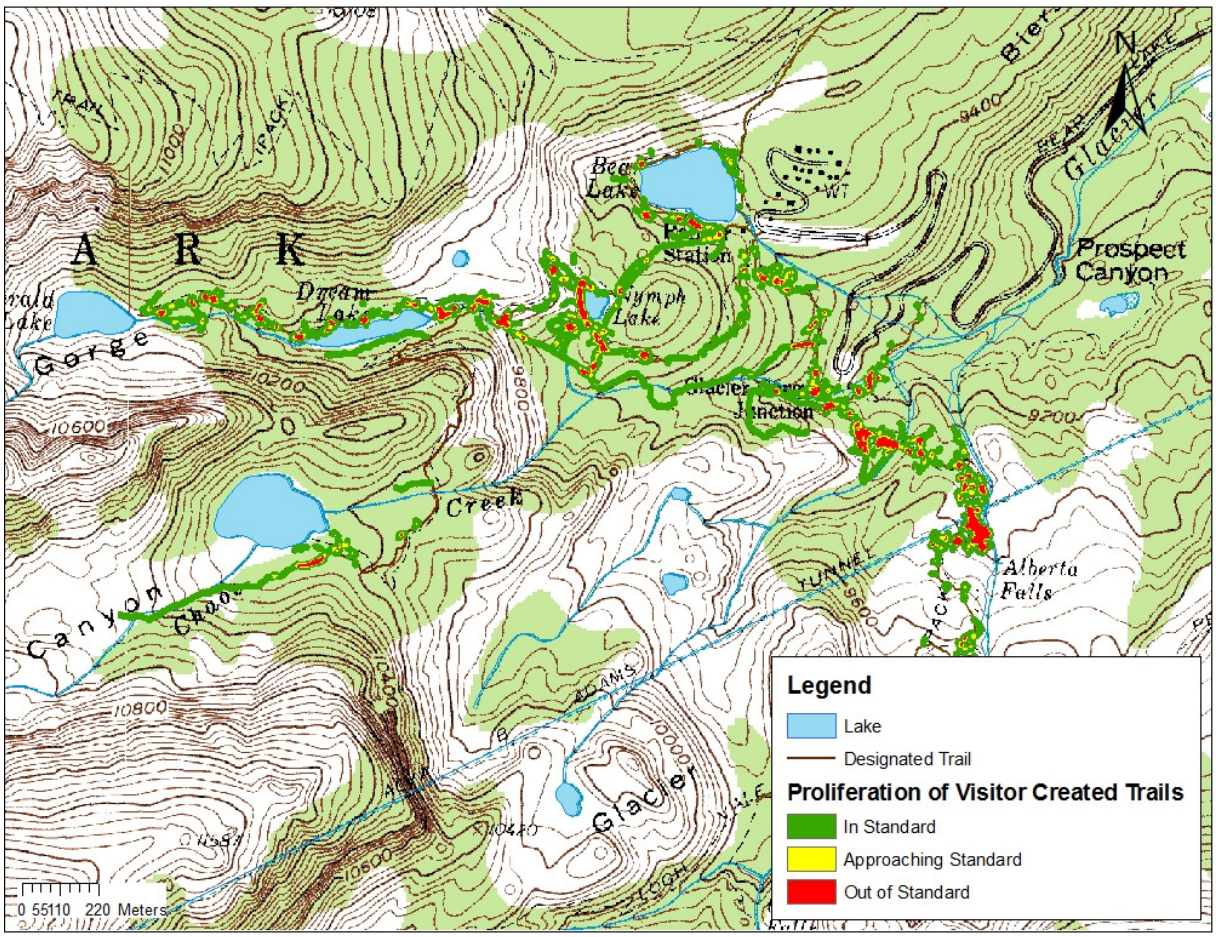


**Fig. 2-7.** Areas where visitor-created trail densities exceed visitor standards.

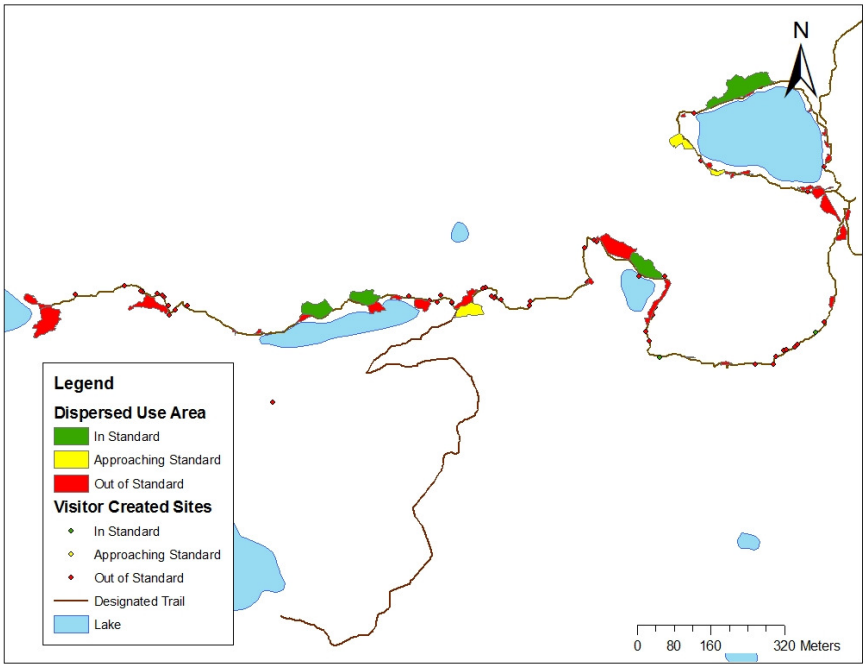


**Fig. 2-8.** Areas where recreation sites exceed visitor standards for Emerald Lake Trail and Bear Lake.

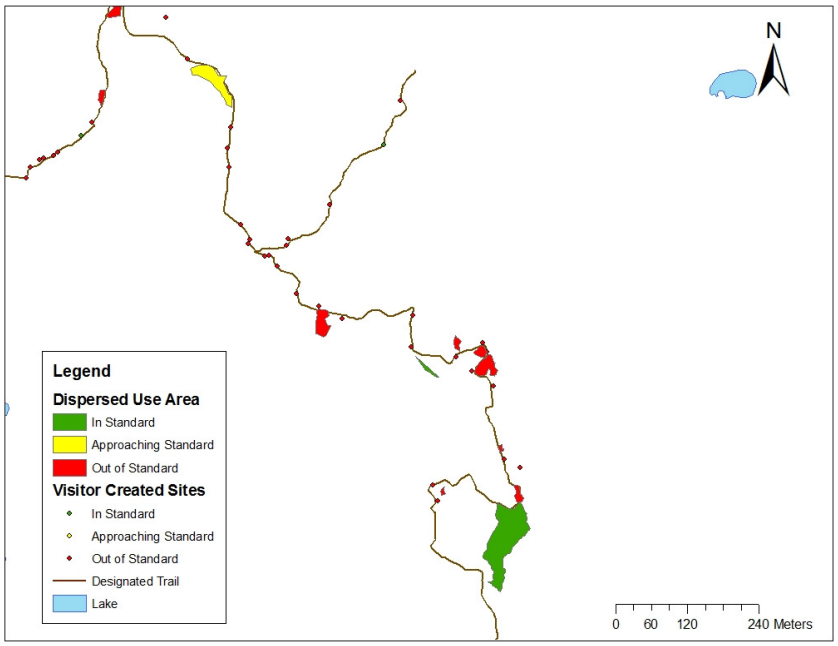


**Fig. 2-9.** Areas where vegetation loss on visitor-created sites exceed visitor standards for Glacier Gorge Trail.

*3.3.2 Visitors' Exposure to Out-of- Standard Resource Conditions*

Integration of the GPS visitor use assessment data and the areas exceeding standard determination provides one context for evaluating the importance of recreation impacts. Visitor contact with areas where visitor-created trail density exceeds acceptability thresholds were estimated by determining the spatial overlap between visitor use and locations where high trail densities occurred (Fig. 2-10). Overall, counts of the frequency of occurrence (i.e., the number of visitor use points that fall in areas where standards are exceeded) indicate that 13% of the time visitors to the Bear Lake Road Corridor are in locations that are out of standard for visitor-created trails and 10% of the time are in locations approaching standard. The density of visitor-created trails is not uniform throughout the trail system, if individual trails are examined the percentage will change to reflect experiences to specific destinations. For example, when the same analysis was performed solely for visitors hiking to Emerald Lake the results showed that visitors spend 23% of their time in locations that are out of standard.

Recreation sites (Fig. 2-11) and areas of dispersed use (Fig. 2-12) were also analyzed for areas of overlap between areas which exceed visitor standards for vegetation loss and visitor use. Unlike the density of visitor-created trails which is a continuous surface, sites were analyzed as discreet units of impact. Therefore, histograms display only the visitor tracking points which came in contact with recreation sites or areas of dispersed use. Frequencies indicate that those visitors who experienced areas of dispersed use (Fig. 2-11) were exposed to areas that were out of standard 48% of the time and areas approaching standard 12% of the time. Visitors being exposed to visitor-created sites (Fig. 2-12) experienced sites exceeding standard 97% of the time.

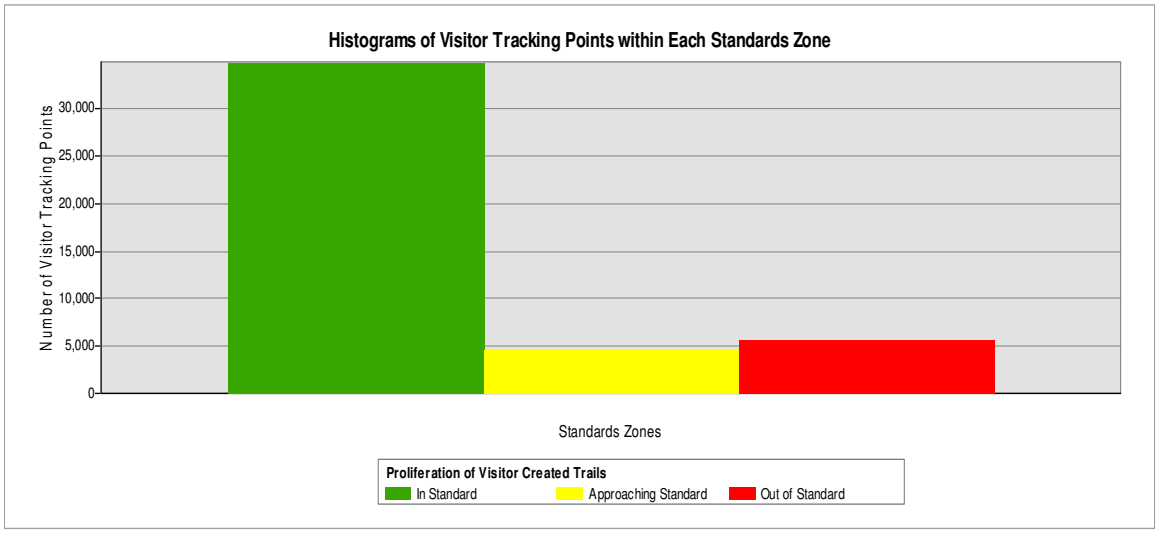


**Fig. 2-10.** Histogram showing overlap of visitor use tracking points and density analysis of visitor-created trails for entire Bear Lake Road Corridor trail system.

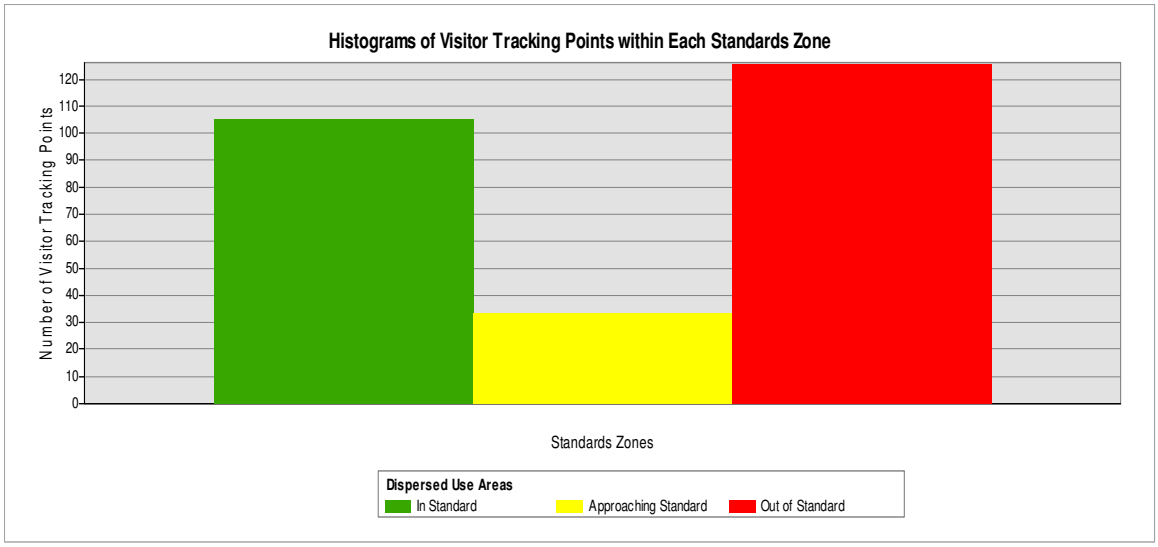


**Fig. 2-11.** Histogram showing overlap of visitor use tracking points and vegetation cover loss on dispersed use areas for entire Bear Lake Road Corridor trail system.

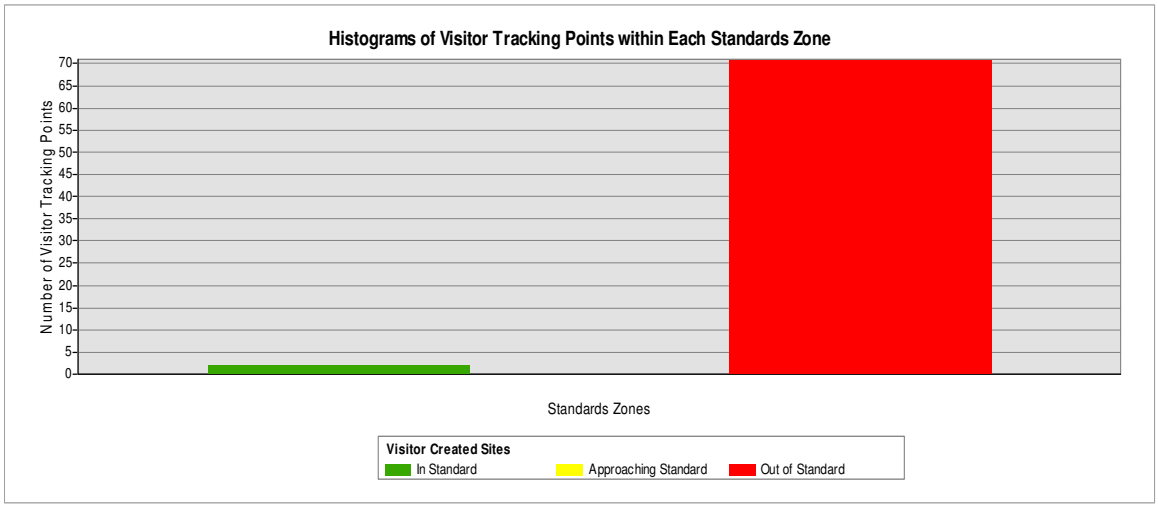


**Fig. 2-12.** Histogram showing overlap of visitor use tracking points and vegetation cover loss on visitor-created sites for entire Bear Lake Road Corridor trail system.

*3.3.3 Areas of Potential Future Resource Change*

Further analysis and integration of the susceptibility modeling of areas surrounding Alberta Falls and Emerald Lake was conducted. A use density layer was determined from the GPS tracking of visitors conducted in this study for these areas. Spatial analysis of the susceptibility and the use density layers allowed for a classification of zones of potential resource change based on these two characteristics (Table 2.4, Fig. 2-13 and 2-14). For example, areas where use level and susceptibility are both high would be classified as having a high potential for resource change.

At Alberta Falls (Fig. 2-13) the areas of highest potential for change are those with high densities of visitors using areas dominated by forbs (especially the spot where the polygon of dispersed use begins to overlap with the designated trail as it turns back towards the falls). The areas with medium potential for change are areas in the polygon and buffer which are dominated by mostly forbs but are receiving medium use.

**Table 2-4.**
Classification of potential resource change scores.

| Score | Visitor Density | Susceptibility |
|---|---|---|
| 2 | Low | Low |
| 3 | Low | Medium |
| 3 | Medium | Low |
| 4 | Medium | Medium |
| 5 | Medium | High |
| 5 | High | Medium |
| 6 | High | High |

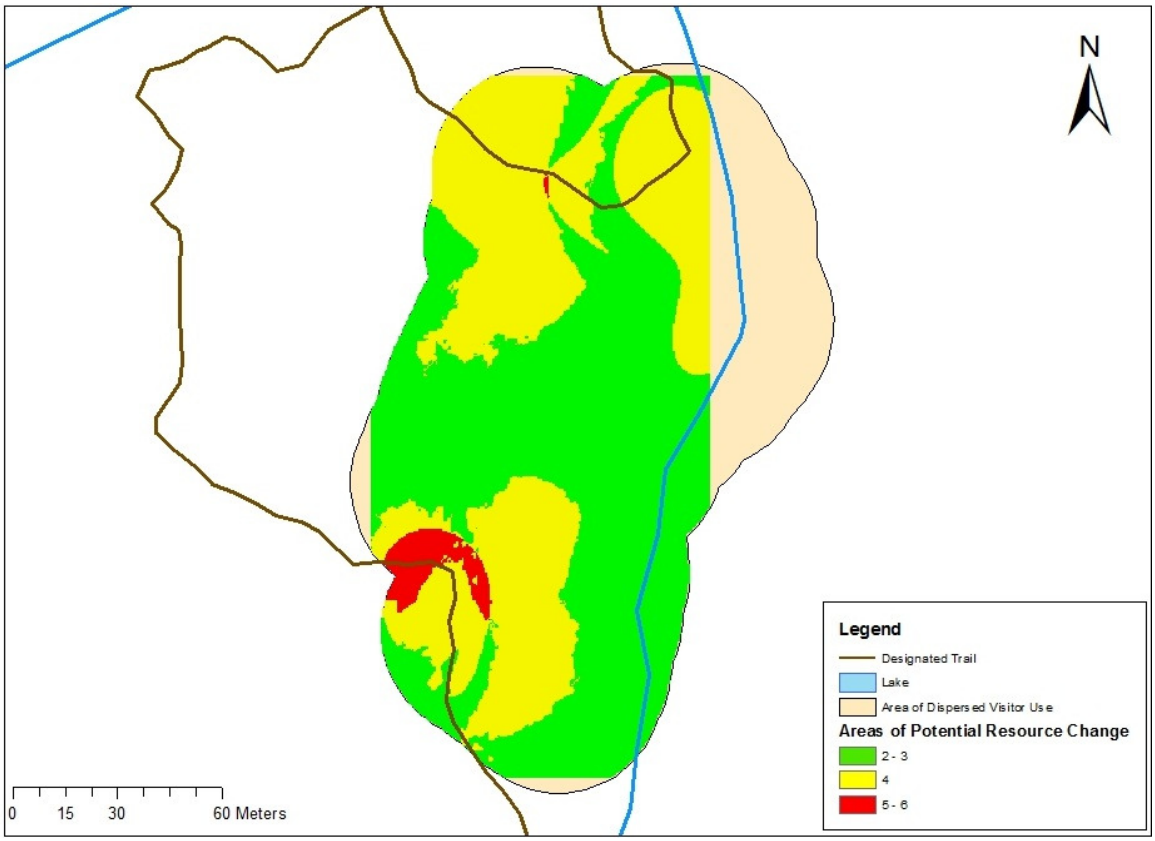


**Fig. 2-13.** Areas of potential resource change at Alberta Falls (red areas are of high potential and green areas are of low potential).

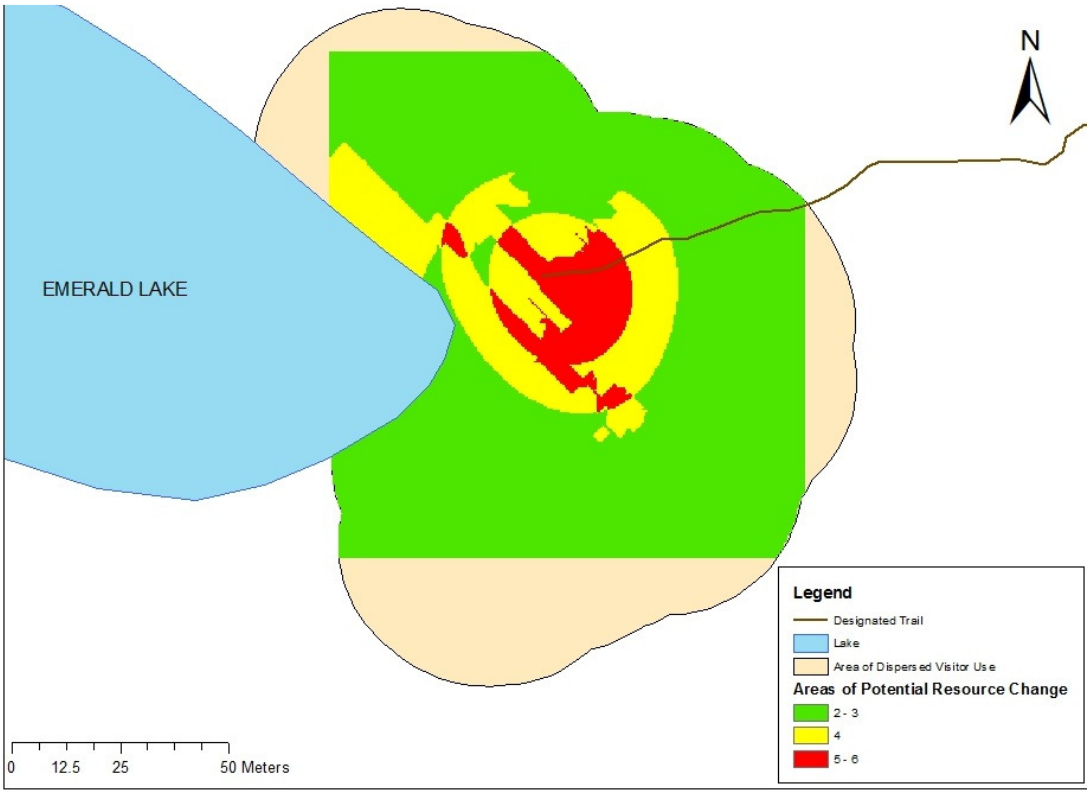


**Fig. 2-14.** Areas of potential resource change at Emerald Lake (red areas are of high potential and green areas are of low potential).

At Alberta Falls, most of the use is confined to the area adjacent to the falls which is primarily exposed rock surface and thus has very low susceptibility and low potential for resource change.

At Emerald Lake (Fig. 2-14) the areas of highest potential for change are found to the east of the rocky lakeshore. Use is highest on these rock surfaces but due to the low susceptibility of the substrate, potential for change is low. The areas of highest potential for change are still receiving a medium to high amount of use but have a high percentage of grasses, forbs, and shrubs compared to the rest of the Emerald Lake area which is mostly dominated by exposed rock surfaces.

**4. Discussion**

The assessment and monitoring of recreation resource conditions is an important information-gathering step in the overall management of park resources. Monitoring programs have been applied effectively in many natural areas (e.g., Frissell, 1978; Cole, 1983; Marion and Leung, 1997), and are fundamental components in the application of long-term planning frameworks such as Visitor Experience and Resource Protection (National Park Service, 1997). Determining trends in resource conditions often highlights the need for management actions and monitoring can help ascertain their effectiveness. Nonetheless, difficult decisions must be made from a management standpoint and assessments and analyses such as those presented here can inform but not accomplish the decision process.

Several aspects of the current assessment are worth noting. First, many recreation disturbances occur in close proximity to the lakes in this study area. Bear Lake, Dream Lake, and Nymph Lake (Fig. 2-2 and 2-3) appear partially problematic in these regards with a considerable length of shoreline and near shore areas disturbed by recreation use. Disturbances in proximity to lake shores have the potential to result in effects to the lake ecosystems such as increased turbidly and nutrient content particularly in high-elevation, oligotrophic lakes (Hammitt and Cole, 1998). Managers should carefully consider these issues and considering, if appropriate, hardening and designating certain areas for lake access thus minimizing additional visitor-created trail formation and site expansion.

Additionally, the proliferation of visitor-created trails appears to be problematic through the trail system. For some trails, such as the Glacier Gorge trail and the Emerald Lake trail, there is almost a threefold difference between the length of designated trail and the length of visitor-created trails (Table 2-3). As with many of the recreation impacts in the study area, visitor-created trails are often established as visitors seek better access to locations such as streams and lakes. Results from the assessment indicate that current management techniques to discourage off

trail use by visitors may not be effective and alternative management action may need to be taken to reduce continued formation of visitor-created trails.

Susceptibility modeling indicates that there are areas which are highly susceptible to resource change at both Alberta Falls and Emerald Lake; two of the more popular hiking destinations in the trail system. Although the rocky nature of Emerald Lake makes the overall area less susceptible to groundcover change (Fig. 2-6), there are still areas of vegetation which may need to be protected from further impact. Alberta Falls has more area that is highly susceptible to groundcover change but the use polygon also contains a substantial amount of rock directly adjacent to Alberta falls itself (Fig. 2-5). Due to the overall susceptibility to the vegetation in the Alberta Falls area a possible management action would be to designate a use area on the bare rock adjacent to the falls as a means of reducing impact in the vegetated areas.

In addition to monitoring trends, an important and growing application of recreation ecology data is the integration with social science approaches, both normative and behavioral (Manning, 2007; Goonan, 2009). These integrated studies have the ability to provide managers with a context from which to begin evaluating the extent and intensity of resource change from a visitor's perspective. While few integrated approaches have been used previously in park research, these methods show substantial future promise.

Areas approaching or exceeding visitor standards for vegetation loss or visitor trail formation are prevalent in the study area. When examined at a system wide level, visitor-created trails are fairly diffuse throughout the trail system and therefore visitors are coming in contact with fewer areas of unacceptable densities of visitor-created trails (Fig. 2-7). Recreation sites that are out of standard (Fig. 2-8 and 2-9), which are more often intensely impacted and found at popular destination sites, such as along lakeshores, are being experienced more frequently by visitors. These results do show that visitors are coming in contact with resources which are considered unacceptable during their visit to the Bear Lake Road Corridor and their experience

may vary based on the particular trail hiked. This information provides the visitor's perspective on the acceptability of resource conditions and should be considered carefully in an overall process of park management. Of particular concern are locations at high value destination points such as Nymph Lake, Dream Lake, and Emerald Lake.

A final integration with social science approaches indicates that medium to high visitor use is occurring, both at Alberta Falls and Emerald Lake, in areas which contain susceptible groundcover species (Fig. 2-13 and 2-14). Although Emerald Lake contains fewer overall areas that are susceptible, high use is occurring in these areas of susceptibility, leading to Emerald Lake containing greater overall area of potential change as compared to Alberta Falls. At Alberta Falls, which contains more areas of susceptible ground cover, the highest use is occurring on the rocky surfaces. Both popular destinations are dominated by areas with medium potential for change, further supporting management consideration for hardening surfaces or attempting to confine use to areas of low susceptibility and reducing visitor use in areas of high susceptibility particularly at Emerald Lake.

## 5. Conclusions

Several important conclusions and implications to park management appear warranted from the above presentation of recreation ecology and integrated research conducted in this study. First, this work provides managers with a spatially explicit census of off trail recreation impacts in the study areas of RMNP. This analysis provides immediate information on the extent and degree of recreation impacts in settings where change may be rapid (off of hardened surfaces and maintained trails) and where managers may choose to implement actions to protect resources other than hardening surfaces. In addition, this information forms the basis for continued monitoring to examine the trajectory of resource conditions over time and to examine the effectiveness of management to limit current and future impacts.

A second conclusion is that visitors appear to be interacting with affected resources for a significant part of their hiking experience in the Bear Lake Road Corridor. While this approach is preliminary and deserves more methodological development, results suggest that, along some trail corridors, 23% of the time visitors are experiencing resource conditions that either approach or exceed visitor standards. Additionally, almost all of the sites that visitors could potentially interact with have unacceptable levels of vegetation cover loss. The integration methodologies used are novel and thus far have not been seen in the literature. Few, if any, studies have attempted to combine social norm data with biophysical conditions found on-site.

A final conclusion is that integration techniques with social science data, such as GPS tracking methodology, can highlight areas of potential, future change. There is potential for further development of these techniques through the analysis of groundcover susceptibility by species, not simply growth form, the results are still informative. Understanding how visitors are using areas which are susceptible to recreation impacts can inform management decisions and set priorities for the protection of resources at particular popular hiking destinations.

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# CHAPTER 3

# UNDERSTANDING VISITOR PERCEPTIONS OF RECREATION RESOURCES IMPACTS IN THE BEAR LAKE ROAD CORRIDOR OF ROCKY MOUNTAIN NATIONAL PARK, COLORADO, USA[1]

**Abstract**

Recreation resource impacts and resource conditions have the potential to affect visitor experiences in parks and protected areas. Of particular concern to researchers are visitor perceptions of resource impacts and the factors that may influence these perceptions. Perceived impacts have the potential to affect the overall quality of visitor experiences; experiences may be diminished if visitors perceive unacceptable levels of impact. Managers of parks and protected areas are concerned about recreation impacts that reduce visitor enjoyment and impair resources used by visitors. An understanding of how visitors perceive environmental conditions, which resource impacts visitors deem unacceptable, and visitor characteristics that influence individual perceptions can provide guidance for management decisions. An on-site questionnaire was administered in the Bear Lake Corridor of Rocky Mountain National Park, CO to examine visitor perceptions of recreation resource impacts. The study examined visitor characteristics that may influence visitor perceptions of specific resource conditions and visitor standards for resource impacts. Visual research methods were utilized to determine visitor standards for specific resource impacts. Findings indicate that visitors are more perceptive of resource impacts that are the result of inappropriate behavior and visitor experiences are most affected by crowding. Local ecological knowledge and knowledge of low impact practices are more influential on visitor perceptions of resource impacts than experience use history. Results suggest that visitors are not perceptive of resource impact with the exception of impacts resulting from depreciative behavior.

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## 1. Introduction

### *1.1 Visitor Perceptions*

Recreational activities in parks and protected areas inevitably lead to some level of resource change. Resource impacts can not only have ecological consequences but social consequences as well. Recreation research suggests that visitors may have thresholds of acceptability for perceived recreation impacts (Hammitt and Cole, 1998; Manning et al., 2004). These visitor perceived impacts have the potential to affect the overall quality of visitor experiences in a park or protected area. Previous perception studies have examined how visitors believe impacts influence attributes, such as solitude or scenic appeal, of the setting in which they are recreating and whether or not visitors view resource change as desirable or undesirable within a particular setting (Leung and Marion, 2000). For managers, understanding what visitors perceive and what effect, if any, their perceptions have on their overall experience can help inform management decisions. Understanding which impacts are perceived can provide managers with a better understanding of the types of impacts that can be used as indictors of the quality of visitor experiences (Farrell et al., 2001).

From recent perceptions literature, two lines of thought have emerged about visitor perceptions of resource impacts. One line of thinking is that visitors do perceive resource impacts, they form judgments about these impacts, and their experience is affected by impacts (Roggenbuck et al., 1993; Lynn and Brown, 2003). The second line of thought is that visitor experiences are not significantly affected by impacts, with the exception of impacts resulting from obvious, inappropriate behavior such as litter and vandalism (White et al., 2001). Studies of perceptions have provided support for both lines of thought concerning visitor perceptions of resource impacts. White et al. (2008) have suggested that the divergent findings in the perceptions research may be attributed to methodological differences between recent studies.

The divergent findings may also be due to the way in which perceptions have traditionally been measured. The scales which have been used in past research, ranking the magnitude of the problem or the level of offensiveness, may imply that visitors should be viewing recreation impacts as problematic or should be offended. Recent research examining the attitudes of visitors towards naturally occurring disturbances in parks and protected areas has taken a slightly different methodological approach to examining visitor perceptions (Kaczensky et al., 2004; Muller and Job, 2009).

For example, in conservation research, perceptions and attitudes are often evaluated using scales which measure the degree to which visitors agree or disagree with statements related to impacts (Kaczensky et al., 2004; Muller and Job, 2009). The application of attitudinal statement scales in visitor perceptions of resource impacts may provide a better reflection of visitor perceptions by eliminating this bias. Conservation studies have also explored the influence of independent variables on visitor perceptions and attitudes not yet examined in the perceptions literature, such as subjective knowledge of a topic, national park affinity, and experience use history (Hammitt et al., 2004; Muller and Job, 2009). Visitor perceptions of recreation impacts may be better understood through the development of unbiased scales and understanding how specific types of resource change may influence the overall visitor experience.

Recently, new methodological approaches have been taken to answer more specific questions about visitor perceptions of resource impacts. For example, Monz (2009) was successful in showing that the stratification of resource impacts by type and location can provide detailed indications of the types of impacts that are perceived by visitors. Although some visitor perceptions research has shown that visitors do in fact perceive certain resource impacts and do make value judgments about them, few studies have been successful in finding factors, or independent variables, which influence visitor perceptions. White et al. (2008) were able to demonstrate that experience use history does influence visitor perceptions. However, in other

studies, experience was shown to have no significant influence on visitor perceptions of impacts (Lynn and Brown, 2003; Monz, 2009). Other recent perceptions studies (Farrell et al., 2001; Monz, 2009) have indicated that visitors may be more accepting of impacts which are viewed as having an amenity value. For example, visitors are more accepting and less perceptive of vegetation loss when the resulting bare ground increases the functionality of an area, such as at a campsite (Farrell et al., 2001).

Visitor perceptions research can provide an understanding of the types of impacts that visitors are sensitive to and how resource impacts influence the visitor experience. Findings from perceptions studies can highlight visitor characteristics which may influence whether or not a visitor perceives impacts. Also, by using visitor survey methods, visitor perceptions research can also provide an understanding of the types of impacts that visitors find acceptable and unacceptable.

*1.2 Normative Theory and Visitor Standards*

Another methodology used in recreation research to understand visitor perceptions of resource impacts employs normative theory. Normative theory was developed in the fields of sociology and socio-psychology; however, recently norm theory has been applied in recreational settings (Heberlein, 1977; Shelby et al., 1983; Shelby and Heberlein, 1986; Manning, 1999). Norms can be evaluated at an individual level or a social level. In general, managers of parks and protected areas are most concerned about the social norms for specific user groups (Manning, 2007). Social norms for a particular condition or issue are often measured using visual survey methodologies for individuals and then the results are aggregated for members of the user group. The result is what is known as a social norm curve (Manning, 2007).

The resulting social norm curve provides a variety of information valuable to managers. The top of the curve represents the optimal preferred condition by the user group (Manning, 1999). Each social norm curve contains a neutral line; conditions below this line are considered

unacceptable to the user group and conditions above are considered acceptable. The point at which the social norm curve intersects the neutral line is the minimum acceptable condition (Manning, 1999). Overall, the methodologies used to assess social norms and the resulting curve can provide managers with information related to visitor standards; informing managers about what conditions visitors find acceptable in a recreation experience.

Although some perception literature indicates that visitors are not incredibly sensitive to resource impacts, visitors may still have standards of quality for resource impacts. Therefore, it is important for managers to understand what level of resource impact is considered unacceptable to visitors. Normative theory and visual survey methods can be used to determine standards for specific types of resource impacts. Managers can include their understanding of the standard of quality for resource impacts in management frameworks such as Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protects (VERP) (Manning et al., 2004).

This study explores the relationship between day use visitor characteristics and day use visitor perceptions of specific resource impacts in the Bear Lake Road Corridor and examines how visitor perceptions of resource impacts influence day use visitors' experiences at the Bear Lake Road Corridor. Visitor characteristic measures were chosen based on those which have been used in conservation attitudes research but not yet examined in the perceptions literature (Muller and Job, 2009). Additionally, the study examines the development of new scales using attitudinal statements as a means of measures visitor perceptions of resource impacts. Finally, the study uses visual survey methods to examine visitor standards for two specific and widespread recreation resource impacts; vegetation cover loss and the proliferation of visitor-created trails. The application of visual methods to these resource impacts is an advancement of this approach as heretofore only changes in the condition of campsites and trails have been examined with these methods (Manning et al., 2004). The results of this study are intended to highlight the recreation

resource impacts that visitors are perceiving and how these impacts influence the visitor experience to better manage for quality visitor experiences along the Bear Lake Road Corridor.

## 2. Materials and Methods

### *2.1 Study Site*

This study was focused on the Bear Lake Road Corridor in Rocky Mountain National Park, CO as part of a larger study investigating the social and resource consequences of visitor use and transportation in the park (Gamble et al., 2007). Due to the elimination of parking constraints to visitor use along Bear Lake Road through the implementation of a shuttle bus system, the Bear Lake Road Corridor trail system has seen increased visitor use levels, especially day use. Anecdotal information from park managers suggest that this increased day use has led to increases in associated experiential and resource impacts.

Two popular trails within the Bear Lake Road Corridor were selected for data collection using a self-administered visitor survey; the Bear Lake trailhead and the Glacier Gorge trailhead (Fig. 3-1). Both trailheads are serviced by the Bear Lake Road shuttle bus and provide access to the majority of the Bear Lake Road Corridor trail system. The Bear Lake trailhead provides access to popular hiking destinations such as Bear Lake, Emerald Lake, and Lake Hiayaha. The Glacier Gorge trailhead provides access to Alberta Falls, Mills Lake, and Sky Pond. Visitors were approached for participation in the study as they exited the Bear Lake or Glacier Gorge trailheads.

### *2.2 Data Collection*

Visitor surveys were administered during July and August of the summer of 2009. Visitors were intercepted at the completion of their hike and asked to voluntarily participate in the study. Each trailhead was sampled for eight days and, in order to collect a representative sample,

**Fig. 3-1:** Study site location with sampled trailheads, Bear Lake and Glacier Gorge, marked with stars.

sampling days were stratified by week days and weekend days as well as morning and afternoon sampling time periods. Morning sampling occurred between approximately 8:30am – 1:30pm while afternoon sampling occurred between approximately 1:30pm and 6:30pm. Sampling only occurred at one trailhead per sampling period. Visitors were intercepted at random during intervals spaced equally over an hour for an even distribution of surveys throughout the overall sampling period.

*2.3 Variables*

The survey instrument collected data on various user characteristics which could potentially influence visitor perceptions of recreation resource impacts (see Appendix A for survey instrument). Experience used history was measured using three indicators. Visitors reported the total number of visits that they have made to Rocky Mountain National Park, the Bear Lake Road Corridor, and to their primary hiking destination (Hammitt et al., 2004; White et al., 2008). National park affinity was measured on a five point Likert-scale of the importance (1= not important, 5 = highly important) of Rocky Mountain National Park to the visitor (Muller and Job, 2009).

Visitors self-rated their knowledge of the natural history and management issues of Rocky Mountain National Park as a measure of local ecological knowledge (1= no knowledge, 2 = some knowledge, 3 = proficient knowledge). Natural history topics included wildlife, plant life, insects, water, geology, and alpine ecology as they relate to Rocky Mountain National Park. Management topics or issues included elk management, vegetation management, fire management, air quality issues, water quality issues, mountain pine beetle, and non-native species. Knowledge of low impact practices was measured using multiple choice questions formulated from the frontcountry principles of Leave No Trace. Each question, and the corresponding correct answer, was based on one of the seven principles of outdoor ethics for frontcountry use as developed by the Leave No Trace Center for Outdoor Ethics (Leave No Trace Center for Outdoor Ethics, 2010).

In order to measure visitor perceptions of recreation resource impacts, visitors responded to attitudinal statements related to specific types of impacts on a five point Likert-scale (1=strongly disagree, 5 = strongly agree). The specific recreation resource impacts examined were common in the study area and would likely be experienced by visitors. These included erosion, trampled vegetation, visitor-created trails, off trail use, tree damage, and solitude/degree of crowding. Resource impact statements were also stratified by perceptions during the visitor's hike and while the visitor was at their primary hiking destination. Visitors responded to questions regarding the effect (added, no effect, or detracted) of recreation resource conditions on their overall experience and whether or not they felt that the specific recreation resource impacts were a problem. Finally, visual research methods were utilized in order to establish standards for vegetation cover at visitor sites as well as standards for the proliferation of visitor-created trails. The degree of vegetation cover and density of visitor-created trails used in the photographs were set using condition classes and observations from a concurrent recreation ecology study

performed in the study area (Chapter 2 this volume). Visitors were asked to rate the photos on a nine-point scale from -4 (very unacceptable) to 4 (very acceptable). (See Appendix B for photos.)

*2.4 Data Analysis*

All statistical tests were conducted using SPSS software (SPSS, Inc., Chicago, IL, USA) Following initial analysis of variables, exploratory structural equation modeling (SEM) using AMOS software with a maximum likelihood estimation approach was used to examine the effect of visitor characteristics on components of visitor perceptions while hiking. Total scores were calculated for the variables of knowledge of natural history topics and management issues. The total scores were combined into a single latent variable of local ecological knowledge. A total score for knowledge of low impact practices ( i.e., knowledge of Leave No Trace) was included as a measured variable. The three experience use history variables were combined into a single latent variable. National park affinity was found to be a less sensitive measure than anticipated and was left out of the SEM. The perception components of noticing impacts and being affect by impacts were modeled with visitor characteristics. The experiential impact of the lack of opportunities of solitude was left out of the analysis to improve model fit and only ecological resource impacts were examined. Consistency of the perceptions scales were assessed using Cronbach's α.

**3. Results**

*3.1 Socio-demographic Profile*

408 usable surveys were collected for an overall response rate of 60%; response rates were similar for both trailheads. The average age of respondents was 47 years of age, males comprised 52% of the participants, and the respondents were well educated. The majority of respondents had a college degree with 35.6% of the total participants having a graduate degree and 32.4% having a bachelor's degree.

*3.2 Visitor Characteristics*

All 408 survey respondents felt that Rocky Mountain National Park was important or highly important to them. The majority of respondents, 70%, rated the park as highly important. On average, visitors had been to Rocky Mountain National Park 37.75 times with 32.3% visiting the park for the first time and 28% of the visitors having visited the park 10 or more times (Table 3-1). For 45.9% of participants it was their first visitor to the Bear Lake Corridor with 21.9% having visited 10 times or more; the average number of reported visits to Bear Lake Corridor was 17.82. Over half, 68.9%, of the participants were visiting their primary hiking destination for the first time with the average number of previous visits to their primary hiking destination being 7.21

Visitor knowledge of natural history topics was self-rated by participates (Table 3-2). Visitors were most knowledgeable about wildlife and plant life. Visitors indicated that they had some knowledge about water, geology, and alpine ecology but were least knowledgeable about insects. Visitors also self-ranked how informed they were of management topics or issues germane to Rocky Mountain National Park (Table 3-2). Visitors were most informed about mountain pine beetle. Management topics and issues that visitors were somewhat informed of included elk management, vegetation management, fire management, air quality issues, and water quality issues. Visitors were least informed about non-native species.

**Table 3-1**
Frequencies of responses and means of responses for experience use history variables; N= 408.

| | Frequency (%) | | | | |
|---|---|---|---|---|---|
| Experience Use History | 1st Visit | 2nd Visit | 3 - 10 visits | >10 visits | Mean +/- SE |
| Total number of visits to Rocky Mountain NP | 32 | 16 | 24 | 28 | 37.75 +/- 7.75 |
| Total number of visits to Bear Lake Corridor | 46 | 11 | 21 | 22 | 17.82 +/- 2.21 |
| Total number of visits to primary hiking destination | 69 | 7 | 17 | 7 | 7.21 +/- 2.29 |

**Table 3-4**
Frequencies and means of responses for self-rated knowledge of local topics and issues; N= 408.

| | Frequencies (%) | | | |
|---|---|---|---|---|
| | No Knowledge | Some Knowledge | Proficient Knowledge | Mean +/- SE |
| Knowledge of Natural History | | | | |
| Wildlife | 10 | 75 | 15 | 2.06 +/- 0.03 |
| Plant life | 22 | 71 | 7 | 1.85 +/- 0.26 |
| Insects | 39 | 57 | 4 | 1.64 +/- 0.03 |
| Water | 24 | 65 | 11 | 1.88 +/- 0.03 |
| Geology | 24 | 66 | 10 | 1.85 +/- 0.28 |
| Alpine ecology | 29 | 63 | 8 | 1.78 +/- 0.28 |
| Knowledge of Management Issues | | | | |
| Elk management | 58 | 30 | 12 | 1.53 +/- 0.03 |
| Vegetation management | 54 | 39 | 7 | 1.53 +/- 0.03 |
| Fire management | 42 | 47 | 11 | 1.69 +/- 0.03 |
| Air quality issues | 52 | 40 | 8 | 1.56 +/- 0.03 |
| Water quality issues | 51 | 40 | 9 | 1.59 +/- 0.03 |
| Mountain pine beetle | 31 | 50 | 19 | 1.88 +/- 0.04 |
| Non-native species | 66 | 29 | 5 | 1.39 +/- 0.03 |

For all natural history topics and management issues, 19% or less of respondents reported themselves as having proficient knowledge.

Visitors were quizzed on their knowledge of Leave No Trace practices for frontcountry settings. Slightly more than half (52%) of all visitors answered all Leave No Trace questions correctly and 40% missed only one question. The question that visitors most often answered incorrectly was related to low impact practices when resting along the trail during a hike. Almost all (99%) visitors answered the questions relating to picking wildflowers, frontcountry campfires, interacting with wildlife, and trail etiquette correctly. About 5% of visitors answered each

question related to the following topic incorrectly; trip preparation, staying on the designated trail, and disposal of trash.

*3.3 Visitor Perceptions*

Attitudinal statements were used to gauge visitor perceptions of recreation resource impacts. Overall, visitors seemed to be less perceptive of almost all resource impacts, with the exception of solitude, at their primary hiking destination than while hiking. The percentage of visitors agreeing or strongly agreeing with the perceptions attitudinal statements were less for when visitors were at their primary hiking destination than while the visitors were hiking (Table 3-3 and Table 3-4). While hiking, the most noticed recreation resource impacts were visitor-created trails, off trail use, and tree damage. The same impacts were also the most noticed impacts at the visitor's primary hiking destination. Both while hiking and at their primary hiking destination, visitors were less aware of erosion, trampled vegetation, and a lack of solitude. While hiking, visitors expected to experience visitor-created trails, off trail use, a lack of solitude, and tree damage; erosion and trampled vegetation were the least expected types of impacts. At their primary hiking destination visitors most expected to experience a lack of solitude. At their primary hiking destination, less than half of the respondents expected to experience erosion, trampled vegetation, visitor-created trails, off trail use, or tree damage. Both while hiking and while at their primary hiking destination, visitors were most affected by tree damage and crowding. Visitors were least affected by erosion, trampled vegetation, visitor-created trails, and off trail use.

Visitors were asked whether the specific recreation resource impacts examined in this study detracted from their experience, added to their experience, or had no effect on their experience. The majority of visitors felt that eroded trails (79%), trampled vegetation (63%), visitor-created trails (57%), and off trail use (63%) did not affect the visitor experience.

**Table 3-5**
Frequencies and means of responses for visitor perceptions of resource impacts while hiking; N= 408.

| Perceptions while hiking | Frequency (%) Strongly Disagree/Disagree | Neutral | Strongly Agree/Agree | Mean +/- SE |
|---|---|---|---|---|
| Perceptions of erosion | | | | |
| Noticed | 37 | 20 | 43 | 3.00 +/- 0.06 |
| Expected to see | 31 | 26 | 43 | 3.09 +/- 0.06 |
| Affected by | 55 | 31 | 14 | 2.36 +/- 0.06 |
| Perceptions of trampled vegetation | | | | |
| Noticed | 38 | 17 | 45 | 3.00 +/- 0.06 |
| Expected to see | 41 | 23 | 36 | 2.89 +/- 0.06 |
| Affected by | 48 | 28 | 24 | 2.57 +/- 0.06 |
| Perceptions of visitor-created trails | | | | |
| Noticed | 19 | 9 | 72 | 3.70 +/- 0.06 |
| Expected to see | 26 | 22 | 52 | 3.28 +/- 0.06 |
| Affected by | 38 | 31 | 31 | 2.81 +/- 0.06 |
| Perceptions of off trail use | | | | |
| Noticed off | 35 | 12 | 53 | 3.22 +/- 0.07 |
| Expected to see | 29 | 21 | 50 | 3.21 +/- 0.06 |
| Affected by | 46 | 27 | 27 | 2.68 +/- 0.06 |
| Perceptions of tree damage | | | | |
| Noticed | 21 | 9 | 70 | 3.76 +/- 0.06 |
| Expected to see | 28 | 21 | 51 | 3.31 +/- 0.06 |
| Affected by | 30 | 22 | 48 | 3.25 +/- 0.07 |
| Perceptions of solitude | | | | |
| Experienced | 42 | 14 | 44 | 3.04 +/- 0.07 |
| Expected to experience | 34 | 16 | 50 | 3.25 +/- 0.06 |
| Affected by crowding | 30 | 25 | 45 | 3.17 +/- 0.06 |

**Table 3-6**
Frequencies and means of responses for resource impacts while at primary hiking destination; N= 408.

| Perceptions at primary hiking destination | Frequency (%) Strongly Disagree/Disagree | Neutral | Strongly Agree/Agree | Mean +/- SE |
|---|---|---|---|---|
| Perceptions of erosion | | | | |
| Noticed | 47 | 23 | 30 | 2.90 +/- 0.06 |
| Expected to see | 35 | 31 | 34 | 2.90 +/- 0.06 |
| Affected by | 55 | 32 | 13 | 2.30 +/- 0.06 |
| Perceptions of trampled vegetation | | | | |
| Noticed | 43 | 20 | 37 | 2.85 +/- 0.06 |
| Expected to see | 40 | 30 | 30 | 2.81 +/- 0.06 |
| Affected by | 48 | 31 | 21 | 2.52 +/- 0.06 |
| Perceptions of visitor-created trails | | | | |
| Noticed | 23 | 17 | 60 | 3.46 +/- 0.06 |
| Expected to see | 29 | 25 | 46 | 3.16 +/- 0.06 |
| Affected by | 39 | 32 | 29 | 2.77 +/- 0.06 |
| Perceptions of off trail use | | | | |
| Noticed | 34 | 16 | 50 | 3.20 +/- 0.07 |
| Expected to see | 30 | 23 | 47 | 3.18 +/- 0.06 |
| Affected by | 46 | 31 | 23 | 2.65 +/- 0.06 |
| Perceptions of tree damage | | | | |
| Noticed | 30 | 13 | 57 | 3.43 +/- 0.07 |
| Expected to see | 32 | 22 | 46 | 3.16 +/- 0.07 |
| Affected by | 35 | 26 | 39 | 3.06 +/- 0.07 |
| Perceptions of solitude | | | | |
| Experienced | 41 | 15 | 44 | 3.04 +/- 0.07 |
| Expected to experience | 31 | 16 | 53 | 3.31 +/- 0.06 |
| Affected by crowding | 33 | 27 | 40 | 3.04 +/- 0.06 |

For tree damage, approximately half of the visitors reported tree damage having no effect on their experience and slightly less than half, 45%, reporting that tree damage detracted from their experience. The degree of crowding experienced was reported by 60% of participants as detracting from their experience.

Visitors were asked to rate whether or not they agreed or disagreed with statements saying that specific recreation resource impacts were problems (Table 3-5). In general, visitors felt that erosion was not a problem or reported a response of 'neutral'. For trampled vegetation, the proliferation of visitor-created trails, and people hiking off trail responses were almost evenly split between disagreeing that these impacts are a problem, reported neutral, or agreeing that these impacts are a problem. Half of the visitors felt that tree damage was a problem in Rocky Mountain National Park with the other half of responses being split between disagreeing and neutral. Approximately half of the visitors felt that the lack of opportunities for solitude was a problem in Rocky Mountain National Park with the remaining responses split between disagreement and neutrality.

*3.4 Visitor Standards*

Visual survey methods were used to determine visitor standards for vegetation loss on visitor-created sites and the proliferation of visitor-created trails. Results indicated that for both vegetation cover and the proliferation of visitor-created trails, increasing levels of impacts are found to be increasingly unacceptable. For vegetation cover, the minimum acceptable level of vegetation cover was 42%; in the photos used this level of vegetation cover corresponded to 53% cover loss. Therefore, any vegetation loss greater than 53% is considered unacceptable to visitors to the Bear Lake Road Corridor (Fig. 3-2). For the proliferation of visitor-created trails, the minimum acceptable condition was 5.7% of the area in the photo being impacted by visitor-created trails. Therefore, any areas where more than 5.7% of the area is impacted by visitor-created trails would be considered unacceptable by visitors to the Bear Lake Road Corridor (Fig.

3-3); 5.7% of the area corresponded to approximately two, average sized visitor-created trails in the photo area.

**Table 3-5**
Frequencies and means of responses for resource impacts being a problem; N= 408.

| | Frequency (%) | | | |
|---|---|---|---|---|
| | Strongly Disagree/Disagree | Neutral | Strongly agree/agree | Mean +/- SE |
| Problem | | | | |
| Erosion of trails | 38 | 37 | 25 | 2.85 +/- 0.05 |
| Trampling of vegetation | 36 | 34 | 30 | 2.91 +/- 0.05 |
| Proliferation of visitor-created trails | 33 | 32 | 35 | 3.02 +/- 0.05 |
| People hiking off trail | 33 | 31 | 36 | 3.04 +/- 0.05 |
| Tree damage | 24 | 25 | 51 | 3.45 +/- 0.06 |
| Lack of opportunities of solitude | 28 | 27 | 45 | 3.25 +/- 0.06 |

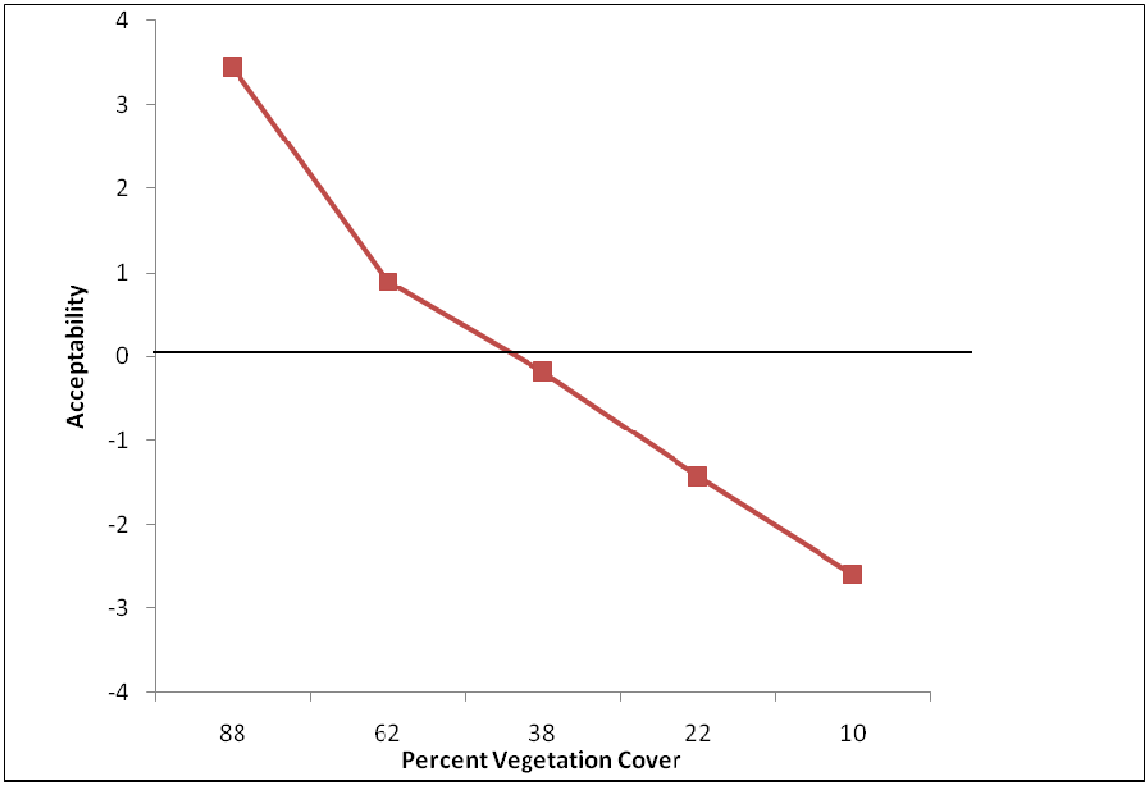


**Fig. 3-2**.Norm curve for vegetation cover on sites.

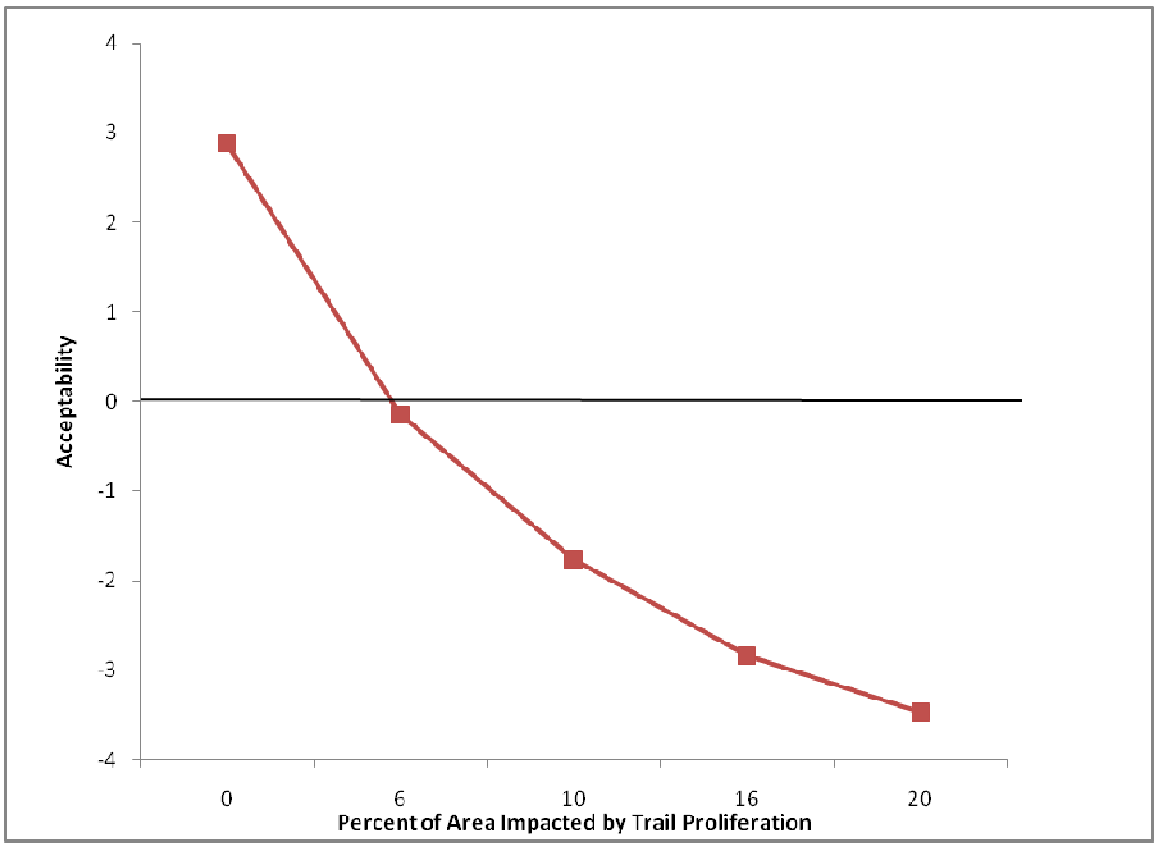


**Fig. 3-3.** Norm curve for the proliferation of visitor-created trails.

*3.5 Structural Equation Modeling*

For noticing ecological resource impacts, reliability analysis indicated that the five statements showed acceptable reliability ($\alpha = 0.66$). Higher internal consistency was found for the statements related to participants being affected by ecological resource impacts ($\alpha = 0.85$). Exploratory SEM techniques resulted in the following model (Fig. 3-4) and fit indices (Table 3-6). A CFI > 0.95 and a RMSEA < 0.05 indicate a good model fit as does an insignificant chi-square value. However, due to the large sample size of the data set, CFI and RMSEA are better measures of fit than the chi-square value. The CFI value of 0.992 and RMSEA value of 0.025 indicate that the model is a good fit.

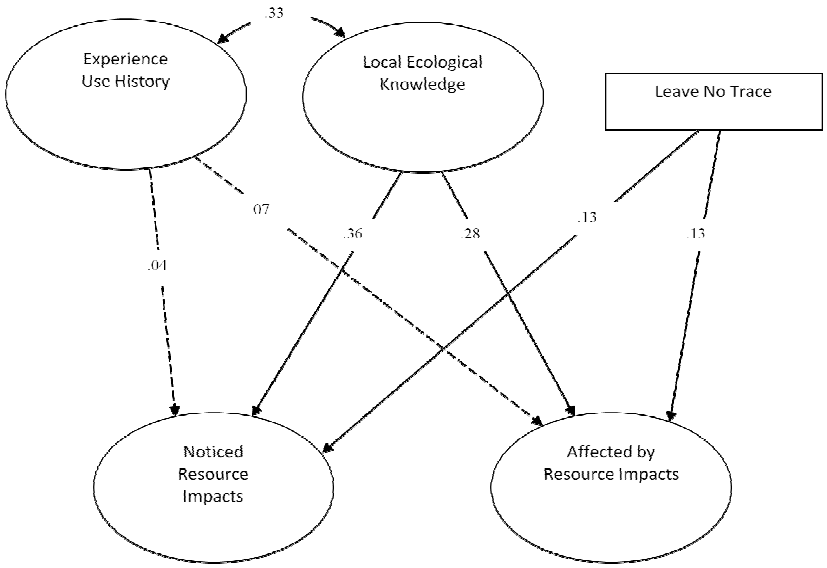


**Fig. 3-4.** Structural equation model with standardized parameter estimates. Dotted lines are insignificant relationships.

**Table 3-6**
Fit indices for structural equation model.

| | $\chi 2$ | df | p | $\chi 2$/df | CFI | RMSEA |
|---|---|---|---|---|---|---|
| Exploratory Model | 110 | 88 | 0.056 | 1.25 | 0.992 | 0.025 |

The relationship between experience use history and noticing or being affected by ecological resource impacts was insignificant. However, both local ecological knowledge and knowledge of low impact practices had a significant, direct, positive effect on noticing ecological resource impacts. A significant, direct, positive effect was also found for visitors being affected by ecological resource impacts (Table 3-7). Overall the model explained 16% of the variance in visitors noticing ecological resource impacts and 11% of the variance in visitors being affected by ecological resource impacts.

**Table 3-7**
Parameter estimates for structural model; N= 408.

| | Dependent Variables | |
|---|---|---|
| Independent Variables | Noticed | Affected |
| Experience Use History | 0.04 | 0.07 |
| Local Ecological Knowledge | 0.36* | 0.28* |
| Leave No Trace Knowledge | 0.13* | 0.12* |
| R2 | 0.16 | 0.11 |

*p<0.05

## 4. Discussion

### *4.1 Visitor Characteristics*

In terms of experience use history, a few generalizations can be made. For visits to Rocky Mountain National Park itself, it appears as if two groups of visitors emerge; those who are first time visitors to the park and those who are frequent visitors (visiting 10 or more times) (Table 3-1). The frequent visitors may be residents of Estes Park or the surrounding metropolitan areas of Denver, Bolder, or Fort Collins. Many of the participants were visiting the Bear Lake Road Corridor for the first time and, even with the large number of repeat visitors, many were visiting their primary hiking destination for the first time. Therefore, although some of the visitors may be familiar with Rocky Mountain National Park as a whole, they may be experiencing the resources, levels of use, and levels of impacts at the Bear Lake Road Corridor or their primary hiking destination for the very first time.

Overall, participates believed that Rocky Mountain National Park is very important to them based on the measure of national park affinity. No participant ranked the park as being unimportant and there were no neutral ratings. In other research national park affinity has been used successfully to stratify respondents by high affinity and low affinity (Muller and Job, 2009), however, in this study the measure proved to be less sensitive than anticipated.

Local ecological knowledge was measured using a self-rated system which does have drawbacks but was the most feasible gauge of local understanding for this study. Other studies have successfully used subjective measures of knowledge to better understand and model respondent attitudes (Ericsson and Heberlein, 2003; McFarlane et al. 2006; Leujak and Ormond, 2007; Muller and Job, 2009). This study was successful in using self-rated measures of ecological knowledge in a modeling effort; however there are opportunities in future work for the further development of these scales (Table 3-2). In general, participants did not feel as if they had proficient knowledge in any of the knowledge topics. Findings indicate that visitors were more familiar with natural history topics than management topics; with over half of visitors reporting no knowledge of all but one management topic. The one exception to this finding is the mountain pine beetle – the management topic for which participates rated themselves as having the most knowledge of.

The mountain pine beetle population in Rocky Mountain National Park is causing significant tree kill resulting in management actions that are directly influencing visitors such as the closing of campgrounds for tree removal. The fact that participates rated themselves as being most knowledgeable about the mountain pine beetle management issue may indicate that visitors are more aware of management practices that have a direct effect on their experience in the park. In support of this concept, participates rated themselves very knowledgeable about the natural history of wildlife and plants in the park however knowledge of elk management and plant management were rated as being low; both management practices which may not be obviously noticed by the visitor. Results from self-rated local ecological knowledge, besides from being used as a variable in modeling, may also have implications for interpretive programs. Participates' perceived level of knowledge can highlight areas where interpretive programs may be lacking. In particular, results indicate that current interpretative plans are ineffective at communicating information related to park management plans and actions.

Overall, participates were very knowledgeable about frontcountry, low impact practices. The majority of participates answered the multiple choice quiz with 100% accuracy. Therefore, most participates know what the correct behavior is for minimizing their impact in the Bear Lake Road Corridor. It is important to note, that visitor knowledge of low impact practices does not necessarily translate into visitor action (Fishbein and Ajzen, 1975). Although visitors demonstrate that they do know proper practices for minimizing their impact they may still act in a depreciative manner. These results have implications for interpretation and outreach in that they highlight the low impact principles which visitors may not be aware of or familiar with. For example, our results indicate that visitors may not know the best place (on the designated trail, or on a social trail, on a rock) at which to take a rest during the middle of their hike. However, visitors are aware that they should not pick wildflowers and should minimize direct interactions with wildlife. Therefore, interpretative efforts in the Bear Lake Road Corridor could emphasize proper trail etiquette and protocol but have effectively communicated low impact practices related to wildlife and leaving what you find.

*4.2 Visitor Perceptions*

Visitors to the Bear Lake Road Corridor of Rocky Mountain National Park appear to be more perceptive of resource impacts while hiking than while at their primary hiking destination. These results may be indicative of the differences between the visitor experiences while visitors are hiking versus while they are at their primary hiking destination (Table 3-3 and 3-4). While hiking, visitors may be more perceptive of the trail itself and their overall surroundings. However, once visitors reach their destination they may be focused on the particular feature of that destination (lake, waterfall, or view). Also, at their destination, visitors may become preoccupied with taking photographs, resting, or eating a meal; making them less perception of the resource impacts around them. Finally, the destinations in the Bear Lake Corridor are often subalpine lakes

with rocky shorelines where visitors disperse. Therefore the resource impacts are more diffuse and, in this particular setting, may be less obvious to visitors.

Despite the difference in magnitude, the same types of resource impacts were perceived by participants both while hiking and while at their primary hiking destination. Visitors were noticing and expecting to see the same types of impacts: tree damage, lack of solitude, off-trail use, and visitor-created trails (Table 3-3 and 3-4). These results support previous findings that visitors are most perceptive of visitor impacts resulting from inappropriate behavior, or in the case of off trail use, the inappropriate behavior itself (Farrell et al., 2001; White et al, 2001; Monz, 2009). Visitors were also perceptive of the experiential impact of not finding solitude in the Bear Lake Road Corridor, and alternatively, experiencing crowding. Visitors do not seem to be as perceptive of erosion and trampled vegetation. These results may indicate that visitors may not understand or recognize erosion. Also, these impacts are more subtle types of resource impacts which can also be caused by natural forces such as water and wildlife. Erosion and trampled vegetation can, and within the Bear Lake Road Corridor often were, the result of inappropriate behavior. However, these impacts are not as obvious as the results of other depreciative behaviors such as tree carving and large, interconnecting social trails.

Overall, the degree of crowding visitors experienced had the greatest effect on the overall visitor experience. Crowding may have affected visitors the most due to visitor expectations. Less than half of the participants reported experiencing solitude either while hiking or while at their primary hiking destination but the majority of participants expected to experience solitude during phases of their trip. The fact that actual conditions did not meet visitor expectations may have influenced how the impact affected the visitor. The same concept applies to tree damage; the second most reported impact affecting the participant. However, still slightly less than half of visitors reported being affected by crowding and tree damage indicating that overall impacts may not be having a great affect on visitors as a whole.

*4.3 Influence of Perceptions on Visitor Experience*

Participants were asked whether the specific types of impacts added, detracted, or had no effect on their overall experience. Most impacts did not affect the overall visitor experience, even the impacts which visitors reported as noticing such as visitor-created trails and off trail use. However, tree damage, which may be the impact most blatantly resulting from inappropriate behavior, was reported by almost half of the participants as detracting from their overall experience. Also, the experiential impact of crowding was reported by over half of visitors as detracting from their overall experience. The same types of impacts which affected visitors are also detracting from their overall experience indicating that, again, visitor expectations may play an important role in understanding how perceived impacts influence the overall visitor experience.

Despite the fact that the Bear Lake Corridor is highly impacted by visitor use, results indicate that participants were not sure whether or not the ecological resource impacts were problems. There was no consensus about erosion, trampled vegetation, the proliferation of visitor-created trails, or people hiking off trail (Table 3-5). The only impacts which had a consensus were tree damage and the lack of opportunities for solitude. Interestingly, tree damage does not appear to be a significant problem in the Bear Lake Road Corridor with most carving being old and healed and very little branch breaking occurring. However, the tree damage that is present is often times very obvious and frequently directly adjacent to designated trails and prolific at destinations. Visitors may be more aware of tree damage due to the obvious nature of the impact, although other types of resource impacts, particularly trampled vegetation and visitor-created trails may, in reality, be a bigger problem. Participants reporting that the lack of opportunities for solitude appearing to be a problem supports the rest of the findings in that

visitors expected to experience solitude did not find solitude, which affected them by detracting from their overall visitor experience. Therefore it seems logical that visitors would perceive visitor use levels as a problem.

It is possible that visitors do not view impacts such as trampled vegetation and visitor-created trails as a problem because these types of impacts have an amenity value. There is support in the literature to suggest that functionality is important to the visitor experience and decreased vegetation cover may increase the functionality of visitor sites (Farrell et al., 2001; Monz, 2009). Trampled vegetation on visitor-created sites may lead to sites which are more functional in terms of view spots and spots for resting or eating. Additionally, visitor-created trails may provide access to off-trail areas which visitors find appealing such as water and rock features. Some level of impact may be acceptable to visitors if the impact increases the enjoyment of their experience (Monz, 2009).

*4.4 Visitor Standards*

Visual survey methods were used to determine visitor standards for the vegetation loss on visitor-created sites and the proliferation of visitor-created trails. These results suppose previous studies (Manning et al., 2004) showing that visitors do have standards for resource impacts. Visitors appear to be more sensitive to the proliferation of visitor-created trails as having any visitor-created trails present was considered unacceptable to respondents (Fig. 3-3). While visitors still have standards for vegetation loss, half of the vegetation needed to be loss from a site before visitors considered the conditions unacceptable (Fig. 3-2). Visitor-created trails are a more obvious result of depreciative behavior and therefore visitors may have been more sensitive since the impact is more obvious. With vegetation loss on sites, visitors may not be able to distinguish between what is natural vegetation loss and what is vegetation loss due to visitor trampling.

*4.5 Structural Equation Modeling*

Past research has found a relationship between experience use history and visitor perceptions of environmental impacts (White et al., 2008). However, our results show that when specific components of perceptions, noticing and being affected by impacts, and other visitor characteristics are measured that the relationship between experience and perceptions is not significant. Our model indicates that the number of times a visitor has visited a place is not as important in terms of perceptions of impacts as the visitors' knowledge of the ecosystem and knowledge of low impact practices (Fig. 3-4 and Table 3-7). These findings support previous research showing that visitors with less local ecological knowledge are generally more accepting of resource impacts (Leujak and Ormond, 2007).

A relationship was also found between experience use history and local ecological knowledge. Each visit may result in the visitor learning something new about the natural history and/or management practices of Rocky Mountain National Park. Therefore, the mechanism through which experience use history influences visitor perceptions, and why past studies which did not measure visitor knowledge have found significant relationships, may be that which each subsequent visit visitors are gaining more local ecological knowledge. Our findings show that the more knowledgeable a visitor is about the natural history and management practices of the place the more likely they are to notice ecological resource impacts and the more likely they are to be affected by these impacts (Table 3-7). Knowledge of low impact practices also influences whether a visitor notices or is affected by ecological resource impacts. A visitor with more knowledge of low impact practices is more likely to notice and be affected by ecological resource impacts.

## 5. Conclusions

This study successfully used newly developed attitudinal statements to examine the specific types of resource impacts that visitors perceive. Overall, visitors appear to be more

perceptive of resource impacts resulting from depreciative behavior and experiential impacts. Although visitors are perceptive of resource impacts, these impacts, with the exception of crowding, are not diminishing the visitor experience. Visitors do have standards for vegetation cover on sites and the proliferation of visitor-created trails. The results from the visual survey methodology support the conclusion that visitors are more perceptive of impacts resulting from depreciative behavior.

The results from this study provide support for the second line of thought currently in the perceptions research. In general, visitor experiences are not affected by resource impacts with the exception of those impacts resulting from inappropriate behavior. Additionally, a visitor's perception of resource impacts is influenced, not as much by how often an individual has visited a place, but by their local knowledge of the place and understanding what behaviors are appropriate for the setting.

Based on the results, despite the high level of impacts in the Bear Lake Road Corridor, visitors do not perceive there to be a management problem (with the exception of crowding). In the case of the Bear Lake Road Corridor, manager perceptions may greatly deviate from visitor perceptions of ecological impacts. SEM findings indicate that visitors may be more perceptive of resource impacts as they gain greater local ecological knowledge and an understanding of low impact practices; a phenomenon initially observed by Manning et al. (2004). These findings are directly contradictory to findings in the literature; suggesting that previously unmeasured visitor use characteristics may be important in understanding visitor perceptions. The importance of visitor knowledge in this study suggests that as interpretative and outreach efforts continue, both within the park and via associated programs such as Leave No Trace, ecological impacts will become more of a visitor experience issue. Additionally, visitors were most perceptive of impacts that were obvious and blatantly the result of human actions. Management may benefit from educating visitors on mechanism of resource impacts. Results from survey indicate that visitors

understand which low impact practices should be used in the Bear Lake Road Corridor but what they may not understand are the consequences of not following those low impact practices. A better understanding of how humans cause resource impact has the potential to influence visitor perceptions of resource impacts. Additionally, although visitors appear to not view a management problem, results do indicate that visitors do have standards of quality for resource impacts and the results from standards studies may provide more useful for making management decisions.

This study examined the use of attitudinal statements for understanding visitor perceptions of resource impacts. The methodology proved to be successful but there is still room for improvement of these scales. Also, although we expanded on current literature by examining different visitor characteristics such as local ecological knowledge and knowledge of low impact practices, there are opportunities to develop these scales further or examine other factors which may influence visitors' perceptions such as environmental worldviews.

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# CHAPTER 4

# SUMMARY AND CONCLUSIONS

The papers presented in this thesis demonstrate how ecological and sociological studies can be integrated to examine current resource conditions and aspects of the visitor experience in a park or protected area. Both papers were part of a larger, interdisciplinary study occurring within the Bear Lake Road Corridor which allowed for integration with additional datasets, such as GPS-based tracking technique. The overall results from this larger study demonstrate that careful planning and question formulation prior to data collection can lead to successful, comprehensive integration of social science data and ecological data.

## 1. Chapter 2 Conclusions

Specific conclusions can be drawn from each chapter. Chapter 2, although largely ecologically based, demonstrates how the data from traditional monitoring and assessment techniques can be integrated with sociological data. Newly developed methodologies show areas of potential change in the trail system and how visitors interact with resource impacts. The integration techniques used in Chapter 2 are new methodologies for examining the relationship between visitor use patterns and ecological conditions. Overall, Chapter 2 indicates that a significant amount of area is impacted within the Bear Lake Road Corridor; particularly at popular hiking destinations. The proliferation of visitor-created trails may be of particular concern as visitors are perceptive of and have standards for visitor-created trails. Although findings indicate that almost all of the visitor sites which visitors are interacting with are out of standard, sites are often found in discrete locations. Visitors are more frequently interacting with visitor-created trails during their travels in the Bear Lake Road Corridor. Results show that many of the densities of visitor-created trails that visitors are experiencing are still within standard. However, there is the potential for the visitor experience to be impacted by the sheer volume of

visitor-created trails which are being perceived and observed by visitors throughout their entire visit in the Bear Lake Road Corridor. Further development of the integration techniques from Chapter II may provide additional insights.

**2. Chapter 3 Conclusions**

Chapter 3 conclusions provide additional support for the line of thought that visitors do not perceive resource impacts with the exception of those resulting from inappropriate behavior. Also, as expected, visitors are most perceptive to crowding and the lack of solitude within the Bear Lake Road Corridor. The experiential impact of crowding is detracting from the visitor experience and if crowding continues to negatively influence the visitor experience, displacement to other areas in Rocky Mountain National Park could occur (White et al., 2008). Subjective characteristics do influence visitor perceptions as demonstrated through SEM. Specifically; visitor knowledge appears to me more important than visitor experience. Additionally, visitors do have standards for specific types of resource impacts and these standards can be measured through visual survey techniques.

**3. Summary and Conclusions from Integration Techniques**

Results from Chapter 3 may indicate that visitor standards are not reflective of the actual visitor experience. For example, Chapter 3 shows that despite the fact that visitors have standards for vegetation loss on sites they do not perceive trampled vegetation. Also, although almost every visitor-created site that visitors are coming in contact with are considered out of standard, visitors to not perceive vegetation loss as a problem. So although visual survey methods indicate that social norms do exist for certain resource impacts and certain levels of impact are undesirable to visitors – visitors may not be viewing these impacts as undesirable when actually experiencing them on the ground.

Overall, the studies indicate that the Bear Lake Road Corridor has been impacted by visitor use at levels which may be of concern for management. Impacts are particularly profound at subalpine and alpine lakes which may have implications for aquatic systems within the Bear Lake Road Corridor. Visitors are experiencing these impacts for a portion of their visit and have standards for vegetation loss on sites and the proliferation of visitor-created trails. However, visitors do not view these ecological impacts as detracting or adding to their experience and do not feel as if ecological resource impacts are a problem.

**4. Management Implications**

Managers are legally mandated to manage for both resource conditions and the visitor experience (The National Park Service Organic Act, § 1, 1916). Integrated, interdisciplinary studies can provide managers with better information for managing this dual charge. Managers at Rocky Mountain National Park must decide how to manage for visitor use and the resulting impacts through the utilization of a management framework. The National Park Service uses an indicators-based adaptive management strategy to manage for resource impacts called Visitor Experience/Resource Protection (VERP) (NPS, 1997). The VERP framework requires that management action be taken when standards of quality are not being met (Manning, 1999). The results from the visual survey methods in Chapter 3 and the integrated mapping from Chapter 2 can be used by managers to determine areas within the Bear Lake Road Corridor that are out of standard for visitor-created sites and the proliferation of visitor-created trails.

Once areas which are considered to be out of standard are identified, resource impacts in the Bear Lake Road Corridor can be managed through restoration efforts which, often within the this setting, results in fencing off areas to visitor use or through hardening of sites. Direct management actions such as fencing are often less acceptable to visitors and can be viewed as a loss of freedom (Manning, 1999). In the Bear Lake Road Corridor, where visitors are not perceptive of the types of impacts restoration attempt to mitigate such as trampled vegetation,

fencing may not be a feasible strategy. Hardening of sites may be a more feasible option within the Bear Lake Road Corridor, particularly at popular destination sites where there is potential for further resource change. Direct management strategies may protect the resource but at the same time detract from the overall visitor experience.

Findings from this study also indicate that there are opportunities for managers to utilize indirect management techniques as well. The results from Chapter 3 show the importance of the role of interpretation in parks and protected areas. Knowledge of natural history and management topics and knowledge of low impact practices were more important than experience in terms of visitors perceiving resource impacts. These findings indicate that there is potential for interpretation to be used as a management technique to influence visitor perceptions. Management actions such as fencing may be more accepted if visitors to the Bear Lake Road Corridor perceived the impacts which are being directly managed. Overall visitors are also more accepting of indirect management techniques such as education (Hammitt and Cole, 1998; Abbe and Manning, 2007). Further education and interpretive programs which focus on the impacts that visitor use can cause in the Bear Lake Road Corridor and showing actual mechanisms and results of resource impacts may change overall visitor standards for resource impacts. Additional education in natural history, management topics, and Leave No Trace practices may result in visitors becoming more sensitive to resource change and potentially changing the level of impacts which visitors consider undesirable.

In the case of the Bear Lake Road Corridor, it can be speculated that researcher and manager perceptions or standards of resource conditions may be inconsistent with visitor standards of resource conditions. Managers and researchers are trained to perceive resource impacts, view them negatively, and attempt to mitigate impacts (Farrell et al., 2001). Although both managers and visitors may be aware of issues of crowding in the Bear Lake trail system, in terms of ecological impacts, managers may believe that resource impacts are a problem.

According to visitor perceptions, there is not a management problem in the Bear Lake Road Corridor, however results from Chapter 2 indicate otherwise. Farrell et al. (2001) believe that there is an inherent problem when management decisions are unchallenged while dismissing visitor ideas about resource impacts. The divergence between perceptions of managers and perceptions of visitors raises interesting questions in terms of how management decisions are made. How should managers determine what levels of resource impacts are undesirable when visitors do not perceive impacts as a problem or when impacts are not diminishing the visitor experience? Are manager standards significantly different from visitor standards and which standards should be incorporated into management frameworks?

Additionally, should only perceived impacts be used as indicators in management frameworks? The results from this study show that although visitors do have standards for vegetation loss, they do not perceive trampled vegetation on sites within the Bear Lake Road Corridor. Farrell et al. (2001) suggest that perceived impacts may be better indicators of quality than unperceived impacts while noting that further research needs to be done in this vein. Visitor perceptions surveys can highlight the types of impacts that can be used as important indicators of the quality of visitor experiences; such as crowding and tree damage. However, managers are charged with a dual mandate, and visual survey methods used to provide visitor standards of resource impacts can help inform decisions related to the protection of resources even if most visitors do not perceive these impacts. Findings from visitor standards work, as well as results from monitoring and assessment work, and manager perceptions are all important components of management frameworks. A decision cannot be based solely on one component as this would result in managers not fulfilling their mandate to both protect the visitor experience and the resources.

Overall, the findings of the two papers presented in this thesis provide managers of Rocky Mountain National Park a place to start in terms of managing for both the visitor

experience and resource protection. Chapter 2 provides an understanding of current conditions, areas of potential concern and change, and areas which are currently out of standard according to visitor standards. Chapter 3 provides an understanding of the types of impacts which visitors perceive and how these resource impacts influence the visitor experience. The subjective factors from Chapter 3 also give insight into the characteristics of the visitors at the Bear Lake Road Corridor and how these characteristics influence visitor perceptions. Both studies add to the recreation resource knowledge base by demonstrating methods in which social science data and ecological data can be integrated successfully to produce meaningful results to guide management decisions.

**5. Future Directions**

New methodological approaches for the integration of ecological data with social science data were outlined in both Chapters 2 and 3; however there is room for further development of these methods and the application of these techniques in different settings. The susceptibility mapping used in Chapter 2 to highlight areas of susceptible ground cover can be made more sensitive by using susceptibility rankings based on the percentage of different ground cover species present. Although ranking based on growth form provides a good indicator of susceptibility, within a single growth form susceptibility varies between species. Chapter 2 and 3 also only examined the integration of visitor standards for visitor-created trails and vegetation loss on sites as these types of impacts were thoroughly measured as part of the monitoring and assessment study. There is potential to use visual survey methods to examine the other ecological resource impacts explored through the visitor perceptions survey; such as different levels of erosion, different condition classes of visitor-created trails, and levels of tree damage. Integration with ecological studies through the resource mapping demonstrated in Chapter 2 is possible for these standards with additional data collection in the field.

The development of GPS-based tracking methodologies also allows for the development and exploration of many new integration techniques. For example, GPS-tracking of visitors can be used to model individual visitor interactions with resource conditions. Further research could integrate both visitor-created trail standards with vegetation loss standards into a single map and use visitor tracking data to model overall visitor interactions with different zones of standards. There is also potential to use viewshed analysis in GIS to make this integration technique more sensitive by incorporating tree cover and elevation changes to better represent the impacts that visitors can see while hiking. Finally, GPS-tracking techniques can be combined with the survey techniques used in Chapter 3 by having participants in the tracking study complete the survey at the conclusion of their trip. This GPS-tracking protocol would allow for linkage to individual survey results, which in turn would indicate the level of resource impacts individual visitors experienced and how it relates to their perceptions.

As there is still support for both lines of thought related to visitor perceptions of resource impacts in the literature, there is much room for further research in this area. Chapter 3 results contradict some findings in the literature and therefore it would be prudent to repeat the study in different circumstances or settings to see if these results hold true. For example, the Bear Lake Road Corridor is highly impacted as indicated from Chapter 2, it would be interesting to explore visitor perceptions in a less impacted area such as in designated Wilderness. Also, since primarily first time visitors and day hikers were examined in Chapter 3, different user groups could be explored; especially since visitor knowledge was an important characteristic in determining perceptions and knowledge may vary with user groups. Within the Bear Lake Road Corridor, bouldering is becoming increasingly popular and managers have become concerned about the impacts resulting from bouldering activities; in terms of management, boulders could therefore be an important user group to evaluate for visitor perceptions. Outside of the Bear Lake

Road Corridor, the methods could be repeated for trail systems primarily used by backpackers or other overnight use.

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# APPENDICES

# APPENDIX A

# SURVEY INSTRUMENT

# Rocky Mountain National Park:
# Bear Lake Corridor Visitor Survey

## Section A: Past Experience and Use History

***We would like to know more about your experience at and use of Rocky Mountain National Park. Please answer the following questions to the best of your ability.***

**1. Including this visit, approximately how many times have you visited Rocky Mountain National Park?**

Number of visits: _____

**2. On the scale below, please indicate how important Rocky Mountain National Park is to you? (Circle one number.)**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Unimportant | | Important | | Highly important |

**4. Including this visit, approximately how many times have you visited to *Bear Lake Corridor* (Bear Lake Trailhead, Bierstadt Lake Trailhead, or Glacier Gorge Trailhead) of Rocky Mountain National park?**

Number of visits: _____

**4. What was the primary destination of your hike today?**

Primary hiking destination: _____

**5. Have you visited your primary hiking destination before today?**

☐ Yes (CONTINUE TO QUESTION 6)
☐ No (SKIP TO QUESTION 7)

**6. Including this visit, approximately how many times have you visited your primary hiking destination?**

Number of visits: _____

**7. During your visit today, at which trailhead did you begin your hike? (Check one.)**

☐ Glacier Gorge Trailhead
☐ Bear Lake Trailhead
☐ Do not know
☐ Other: _____

**8. On your hike today, which locations did you visit? (Check all that apply.)**

☐ Bear Lake
☐ Bierstadt Lake
☐ Flattop Mountain
☐ Alberta Falls
☐ Mills Lake
☐ Jewel Lake
☐ Black Lake
☐ Loch Vale
☐ Sky Pond
☐ Lake Hiayaha
☐ Dream Lake
☐ Emerald Lake
☐ Nymph Lake
☐ None of the above
☐ Do not know
☐ Other:_____

## Section B: Knowledge of Natural History and Ecological Issues

1. **We would like to know more about your knowledge of the *natural history* of Rocky Mountain National Park. For each natural history topic below, please rank your knowledge of this topic *as it relates to Rocky Mountain National Park* by checking the appropriate box.**

| Topic | No Knowledge | Some Knowledge | Proficient Knowledge |
|---|---|---|---|
| a. Wildlife | | | |
| b. Plants | | | |
| c. Insects | | | |
| d. Water | | | |
| e. Geology | | | |
| f. Alpine Ecology | | | |

2. **We would like to know more about your knowledge of some *ecological issues* in Rocky Mountain National Park. For each ecological issue below, please rank your knowledge of this topic *as it relates to Rocky Mountain National Park* by checking the appropriate box.**

| Topic | No Knowledge | Somewhat Familiar | Well Informed |
|---|---|---|---|
| a. Elk Management | | | |
| b. Vegetation Management | | | |
| c. Fire Management | | | |
| d. Air Quality | | | |
| e. Water Quality | | | |
| f. Mountain Pine Beetle | | | |
| g. Nonnative Species | | | |

## Definitions for the remaining questions in the survey

***Designated trail:*** The hiking trail constructed by the National Park Service for visitor use; those that are found on National Park Service maps.

***Visitor-created trail:*** A trail not constructed, nor maintained, by the National Park Service which was created by repeated use of persons hiking away from the designated trail.

## Section C: Knowledge of Hiking and Camping Practices

***We would like to know more about your knowledge of hiking and camping practices. Please answer the following questions to the best of your ability by checking the box next to the correct answer.***

**1. In preparation for a hike in Rocky Mountain National Park, which of the following is correct?**

- ☐ Plan to start your hike later in the day to avoid being above tree line during a storm.
- ☐ Learn about the hike you will be attempting by reading guide books and studying maps.
- ☐ Carry as little as possible to allow for faster hiking.
- ☐ Leave your rain jacket at home; it is not necessary during summer months.

**2. When hiking in Rocky Mountain National Park, which of the following best practices should you do?**

- ☐ Travel in large groups.
- ☐ Talk loudly, sing, or yell while hiking to scare away bears.
- ☐ Always stay on the designated trail.
- ☐ Travel along visitor-created trails.

**3. You have just finished eating lunch along the trail, which of the following can be disposed of in the woods?**

- ☐ Fruit and vegetation scraps such as orange peels and apple cores.
- ☐ Any food item that will decompose.
- ☐ Meat or fish scraps.
- ☐ None of the above.

**4. When you are hiking on a trail with wildflowers, which of the following should you do?**

- ☐ Walk off of the trail and pick a flower no one can see.
- ☐ Stay on the trail and pick only one flower.
- ☐ Do not pick any flowers.
- ☐ Pick only dry, wilted flowers and leave the healthy plants alone.

**5. When having a campfire at your campsite, which of the following should you do?**

- ☐ Make sure the fire is completely extinguished before leaving your campsite.
- ☐ Build the fire as large as possible for maximum heat.
- ☐ Burn your trash and food scraps in the fire.
- ☐ Leave large pieces of partially burnt wood for others to use.

**6. When viewing wildlife, which of the following should you do?**

- ☐ Get as close as possible for a great photograph.
- ☐ Feed the wildlife, especially during winter when food may be scare.
- ☐ Try to scare the wildlife away from other visitors.
- ☐ Respectfully observe the wildlife from a safe distance.

**7. When stopping to rest during your hike, which of the following should you do?**

- ☐ Stand in the middle of the designated trail.
- ☐ Sit on a rock or log.
- ☐ Use a visitor-created trail to find a quiet place away from the designated trail.
- ☐ Find a shady spot beneath a tree and rest there.

## Section D: Perceptions of Resource Conditions

**1. We would like to know how you feel about your experience today at the Bear Lake Corridor of Rocky Mountain National Park; both during your hike and at your primary hiking destination. For each statement below:**

**1. Rate how much you agree or disagree that the statement describes your experience *during your hike* to your primary hiking destination in the Bear Lake Corridor.**

**2. Rate how much you agree or disagree that the statement describes your experience *at your primary hiking destination* in the Bear Lake Corridor.**

| Statements | During your hike | | | | | At your primary hiking destination | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 = Strongly disagree<br>2 = Disagree<br>3 = Neutral<br>4 = Agree<br>5 = Strongly Agree | | | | | 1 = Strongly disagree<br>2 = Disagree<br>3 = Neutral<br>4 = Agree<br>5 = Strongly Agree | | | | |
| a. I noticed eroded trails. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| b. I expected to see eroded trails. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| c. The amount of erosion that I observed affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| d. I noticed areas where vegetation had been stepped on or trampled. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| e. I expected to see trampled vegetation. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| f. The amount of trampled vegetation that I observed affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| g. I noticed trails that had been created by visitors. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| h. I expected to see visitor-created trails. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| i. The amount of visitor-created trails that I observed affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| j. I noticed other visitors hiking off of the designated trail. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| k. I expected to see visitors hiking off of the designated trail. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| l. The amount of people that I observed hiking off of the designated trail affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| m. I noticed tree damage. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| n. I expected to see tree damage. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| o. The amount of tree damage that I observed affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| p. I experienced solitude. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| q. I expected to experience solitude. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| r. The degree of crowding that I experienced affected me. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |

**2. We would like to know more about how the various resource conditions that you may have experienced today impacted your visit to the Bear Lake Corridor. For each resource condition below, please rank how you feel the *resource condition* influenced your *overall experience* today in the Bear Lake Corridor.**

| Resource Condition | Detracted from Experience | No Effect on Experience | Added to Experience |
|---|---|---|---|
| a. Eroded trails | 1 | 2 | 3 |
| b. Trampled vegetation | 1 | 2 | 3 |
| c. Visitor-created trails | 1 | 2 | 3 |
| d. People hiking off of the designated trail | 1 | 2 | 3 |
| e. Tree damage | 1 | 2 | 3 |
| f. Degree of crowding | 1 | 2 | 3 |

**3. We would like to know how you feel about resource conditions at the Bear Lake Corridor of Rocky Mountain National Park. For each statement below, rate how much you agree or disagree that the statement describes your feelings about *resource conditions* in the Bear Lake Corridor.**

| Statement | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| a. Erosion of trails appears to be a problem. | 1 | 2 | 3 | 4 | 5 |
| b. Trampling of vegetation appears to be a problem. | 1 | 2 | 3 | 4 | 5 |
| c. The proliferation of visitor-created trails appears to be a problem. | 1 | 2 | 3 | 4 | 5 |
| d. People hiking off of the designated trail appears to be a problem. | 1 | 2 | 3 | 4 | 5 |
| e. Tree damage appears to be a problem. | 1 | 2 | 3 | 4 | 5 |
| f. The lack of opportunities for solitude appears to be a problem. | 1 | 2 | 3 | 4 | 5 |

## Section E: Visitor Standards of Resource Conditions

1. **We would like to know more about your view of *resource conditions* in the Bear Lake Corridor. Please rate each of the photographs found in the associated binders by indicating how acceptable you find the photograph based on the amount of resource condition change that you observe. (Circle one number for each photo)**

**Photo Group 1:**

| | **Very Unacceptable** | | | | | | | | **Very Acceptable** |
|---|---|---|---|---|---|---|---|---|---|
| Photo 1 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 2 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 3 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 4 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |

**Photo Group 2:**

| | **Very Unacceptable** | | | | | | | | **Very Acceptable** |
|---|---|---|---|---|---|---|---|---|---|
| Photo 1 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 2 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 3 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 4 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| Photo 5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |

## Section F: Background Information

***We would like to collection some background information. Please answer the following questions to the best of your ability.***

**1. What is your gender? (Check one.)**

☐ Male
☐ Female

**2. In what year were you born?**

Year born: 19_____

**3. Do you live in the United States? (Check one.)**

☐ Yes - What is your zip code? _____
☐ No - In what country do you reside? _____

**4. What is the highest level of formal education that you have completed? (Check one.)**

☐ Some high school
☐ High school graduate or GED
☐ Some college (Associate's or Bachelor's level), business or trade school
☐ College (Associate's or Bachelor's degree), business or trade school graduate
☐ Some graduate school (Master's, Doctoral, or Professional degree level)
☐ Master's, Doctoral or Professional degree

**Thank you very much for your help with this survey!**

**Please use the back of this page for any additional information or comments.**

**When completed, please return the survey to a survey administrator.**

# APPENDIX B

# VISITOR STANDARDS PHOTOS

Vegetation Loss Photo 1

Vegetation Loss Photo 2

Vegetation Loss Photo 3

Vegetation Loss Photo 4

Vegetation Loss Photo 5

Proliferation of Visitor-created trails Photo 1

Proliferation of Visitor-created trails Photo 2

Proliferation of Visitor-created trails Photo 3

Proliferation of Visitor-created trails Photo 4

Proliferation of Visitor-created trails Photo 5